Environmental Management Systems:

Do They Improve Performance?

NATIONAL DATABASE ON ENVIRONMENTAL MANAGEMENT SYSTEMS

Project Final Report: Volume II

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Chapter 10. Environmental Performance and Compliance Changes

INTRODUCTION

One of the core objectives of this study was to provide answers to the question, what effects does the implementation of an EMS have on a facility's environmental performance? Previous studies have not provided clear answers to this question. Self-reported data (both case-study reports and survey results) point somewhat consistently to improvements in several facets of environmental performance. In an assessment of the environmental reports of ten of the world's largest pharmaceutical companies, Berry and Rondinelli (2000) found that environmental management practices were beginning to produce positive results, and that considerable progress had been made in waste reduction, resource conservation, hazardous emissions, and ozone depleting chemicals. Early survey-based studies have also begun to report EMS impacts on environmental performance. Melnyk and others (1999), for instance, found that ISO 14001 was more effective at impacting environmental performance than were other voluntary programs. Hamschmidt (2000) surveyed all ISO-certified companies in Switzerland in 1999, and found that 60% of the 158 companies responding (just over 50% of all companies) reported some decrease in materials and energy flows relative to production, but that only 10% of the firms had experienced strong decreases, and 40% either did not measure changes or experienced worse performance.

More recent studies, however, have begun to produce larger statistical studies. Florida and Davison (2001), for instance, reported results from a survey of 580 corporations in Pennsylvania, finding that facilities with EMSs were significantly more likely than others to report recycling, air emission reduction, solid waste reduction and electricity use as evidence of facility-level improvement. Similarly, Mohammed (2000), in a survey of 106 ISO-certified firms in the Chubu region of Central Japan, found that firms claim to manage their natural resource consumption more efficiently after adopting an EMS. And Anton et al. (2002), surveying a sample of Fortune 500 firms, found that a higher-quality EMS leads to lower toxic emissions per unit output, particularly for firms that had higher past pollution intensity. They also found that EMSs result in reductions in both off-site transfers and on-site releases per unit output, though not in hazardous air pollutants per unit output.

Two studies so far have attempted to go beyond self-reported data on performance outcomes, and examined EMS adopters' environmental performance as measured by EPA's TRI (Toxics Release Inventory) database. Matthews (2001) examined TRI data for EMS adopters in the automobile and light truck assembly sector, and reported that facilities with ISO 14001 were not performing significantly better than facilities without the system: she found no differences in toxic waste management between certified and non-certified facilities, and compliance with air permits was similar between certified and non-certified facilities. However, TRI data are

reported with a two-year lag time, and it is not clear that her results accurately represented facility performance after EMS implementation and certification.[73] Contrary to these findings, Russo (2001) found that in the electronics industry, ISO 14001 registration significantly reduced toxic emissions in facilities with releases above TRI reporting thresholds, and that an EMS was a significant predictor of improved environmental performance with respect to toxic emissions.

The results of these prior investigations suggest a number of propositions for further examination. More specifically, the contradictory conclusion drawn by Matthews and Russo as well as the mixed results found in the Hamschmidt study suggest three possible performance outcomes as a result of EMS implementation: introducing an EMS makes no observable difference at all to a facility's environmental performance, EMSs will produce improvements in environmental performance or performance could actually appear to deteriorate following introduction of an EMS.

While the results of this study are unlikely to provide a definitive answer in favor of any one proposition, it has the potential to contribute additional evidence for either argument. More specifically, this study examines the influence of EMS adoption on environmental performance outcomes at 37 facilities that reported data to the NDEMS project. The following sections describe the data and rationale utilized to evaluate changes in environmental performance, as well as the methods that were used to draw our conclusions.

DATA AND METHODOLOGY

The NDEMS protocols asked that facilities identify and briefly describe all indicators used to measure the environmental performance of the facility, as well as any violations or non-compliance with federal, state or local regulations. First-update data were provided by 37 facilities, which comprise the sample for these analyses. The data cover a period of approximately 2.5 years, on average, after reporting their baseline data; this included the period during which the EMS was being developed and introduced.[74]

These facilities provided update data for baseline environmental performance indicators (EPIs) that the facility developed during their baseline period and which the facilities continue to monitor. Facilities also reported any instances of violations or non-compliances that occurred at the site during this time frame. Methods employed to evaluate performance outcomes at the facilities are described below. These 37 facilities were then compared to the non-reporting NDEMS facilities in order to determine whether they were representative of all study participants, and to illuminate any bias that may exist. A description of the statistical tests used to evaluate variations in performance outcomes follows the methodological descriptions.

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[73] In her study, Matthews apparently chose to assume that facilities would have implemented their most cost-effective environmental performance improvements in preparation for initial ISO registration audits, rather than as a result of them; her TRI data (1994-98) did not in fact cover the period after the facilities' ISO certification.

[74] Actual dates of EMS "implementation" varied. Many facilities were unable to point to a specific date at which the EMS was implemented; some considered their EMSs to be constantly evolving and thus never completely "implemented."

Environmental Performance Indicators - Evaluation Methodology

Twenty-seven of the 37 update respondents provided data on their Environmental Performance Indicators.[75] These values established a range of pre-EMS performance for each indicator at each facility.[76] An indicator was considered to have exhibited change if the reported value of that indicator during the update period was outside the extremes of performance during the three-year baseline period.

To make this assessment, all EPIs were first normalized by factors specified by the facility.[77] For each indicator, the highest and the lowest baseline values were then identified.[78] If the value of an updated EPI was worse than the worst baseline value, performance was coded as deteriorated ("1"). If the update value was better than the best baseline value, EPI performance was coded as improved ("3"). If the update EPI fell within the range of the baseline values, it was coded as unchanged ("2"). Figure X-1 illustrates this method using an actual report from a pilot facility and two hypothetical update values to illustrate other potential performance outcomes.

Results of this assessment were aggregated to the facility level and an Environmental Indicator Performance Index (EIPI) score was constructed based on the proportion of that facility's EPIs that improved during the update period.[79] For instance, facility #7 in Figure X-3 below reported data on eleven EPIs during the baseline and update periods. Our evaluation of each indicator's performance as described above, categorized five indicators (0.46) improved, while three indicators (0.27) were unchanged and an additional three indicators (0.27) showed deteriorated performance. The EIPI score assessed for this facility was 0.46.

[75] This includes one facility that was recruited from outside the initial Pilot Program states, in addition to the 36 NDEMS pilot facilities that completed the First Update protocol.

[76] An alternate method of evaluation might have been to compare update values of these EPIs to a projected value based on the prior performance of these indicators. However, facilities in this study provided data for a maximum of only three years prior to EMS development, and this limited number of data points did not appear sufficient to make reliable projections on indicator performance.

[77] Most facilities (23) chose normalization factor(s) to be used for specific EPIs. However, if the facility was not able to provide a normalization factor, the number of employees at the facility was used.

[78] Embedded in this assessment is the assumption that larger values for discharges are worse than smaller values. Conversely, larger values of recycled or reclaimed materials are better than smaller values.

[79] Construction of this facility level index remedied several issues that otherwise confound performance evaluations. First, it eliminates our concern about comparability between indicators resulting from differences in reporting units, frequencies and normalization, as performance scores are not contingent upon an EPI's relationship to other indicators. Second, the index ameliorates issues that arise from differences in the number of EPIs particular facilities choose to track. Specifically, facilities that focus on larger numbers of EPIs do not unduly influence considerations of differences in performance. Finally, this score addresses the challenge presented when facility performance outcomes are ambiguous. For example, in this sample the majority of facilities' EPI performance spanned the range of all possible outcomes.

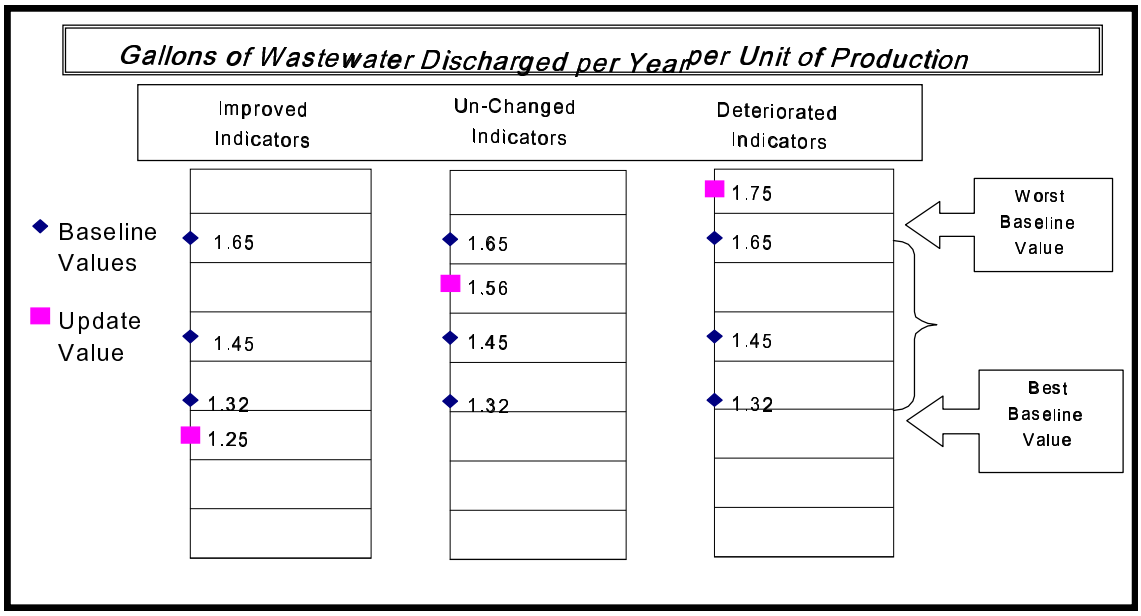


Figure X-1: Assessment of Change in EPI Values

A second performance index was also constructed to account for the possibility that some indicators, particularly indicators that were related to a facility's objectives and targets, might better account for the influence of the EMS process on environmental performance. To construct this index, each facility's EPIs was compared to the objectives and targets that had been selected in that facility's EMS process and provided to NDEMS in the EMS Design data. Where a logical connection was observed between a particular EPI and a documented objective or target of the facility, the EPI was placed into a second sample for further evaluation.

After all facility EPIs that were related to an objective or target (EPIOT) were identified and segregated, the proportion of these EPIs that improved during the update period for each facility was reassessed and a separate index score (EIPIOT) was assigned to the facility based on the process outlined above. For example, as described above facility #7 reported eleven EPIs. Only one of these EPIs was related to the facility objectives and targets. In this instance, the indicator had been coded as deteriorated in the initial evaluation. Since the indicator was not improved, the facility's assessed EIPIOT score was 0.00. The distribution of facility scores was then examined to determine if variability in EPI performance existed.

Statistical Methods and Techniques

Since certain assumptions made with standard statistical tests cannot be made about our sample (e.g., normality of distribution), non-parametric methods were used to test differences between performance outcomes and to make comparisons between groups.[80] Several tests were used in this analysis:

[80] Non-parametric tests necessarily do not make the standard assumptions that define their parametric counterparts (t-test, Pearson correlation coefficient, etc.), and therefore produce highly conservative *p*-

1. *The Wilcoxon rank sum test* was used to determine differences between continuous dependent variables in independent samples (e.g., differences in EIPI scores at larger versus small facilities).
2. *Fisher's exact test* was used to determine differences between dichotomous or categorical variables in independent samples (e.g., differences between facilities that eliminated regulatory compliance issues and those that did not).
3. *Spearman's rho* was used to measure the strength of correlation between two or more characteristics and to test for collinearity between independent variables.

RESULTS

Descriptive Statistics

Environmental Performance Results – Sample Representativeness

The 37 facilities that reported update data were similar to the facilities in the NDEMS study that did not report post-design data. The same 20 business sectors were represented in this update sample, and the distribution of facilities within these sectors was similar. The majority of the update facilities were manufacturers (70 percent), and facilities of varying sizes (number of employees) were similarly represented. As was true for the majority of facilities that provided baseline and design data, most facilities reporting during the update period were subsidiaries of larger organizations (78 percent), and majorities of these parent organizations produced (51 percent) and marketed (70 percent) their products and services outside as well as within the United States.

Facility ownership was also similar. Facilities affiliated with publicly traded companies represented the largest proportion of facility ownership (41 percent); privately held facilities accounted for more than a third (38 percent); and the remaining respondents were government facilities (22 percent). Table X-1 shows these demographics. The facilities reporting during the update period gave similar descriptions of the areas in which they operated, and were located in communities of similar populations. Facilities reporting update data were as likely as non-reporting facilities to have designed EMSs that covered all site operations (86 percent).

TABLE X-1: OWNERSHIP OF UPDATE FACILITIES

Update Status	Publicly Traded	Privately Held	Government Owned	Totals
Reporting	15	14	8	37
Non-Reporting	18	14	14	46

Baseline management experience (both general and environmental) was strikingly similar between reporting and non-reporting facilities. Most of the facilities reporting during the update period had some baseline experience with general management systems (70 percent).

values. For this reason, more liberal levels of significance ($p < 0.10$) are sometimes considered acceptable, in addition to conventional levels ($p < 0.05$) (Kahn and Goldenberg 1991).

Half (51 percent) had participated in a voluntary environmental management initiative, and more than three-quarters (81 percent) had previously employed other environmental management techniques at their site.

The baseline EMSs designed by these reporting facilities were similar to those of non-reporting facilities. More than two-thirds of the update facilities (70 percent) had previously begun developing EMSs with at least one feature of an ISO 14001 EMS. Update facilities also were as likely as non-update facilities to have performed a gap analysis on their baseline EMS (47 percent).

Table X-2 shows the number of facilities whose baseline EMS was observed to include several "core" elements of the ISO 14001 EMS (environmental policy, identified regulatory requirements, identification of environmental aspects and impacts, established environmental objectives and targets and either a time-frame or a method by which to realize these environmental objective and targets).

Facilities reporting update data were as likely as non-reporting facilities to have been involved in pollution prevention activities (84 percent) and to have developed formal pollution prevention plans (49 percent) during the baseline period.

TABLE X-2: BASELINE EMS INCLUDES "CORE" ISO FEATURES

Update Status	Baseline EMS Core ISO	Baseline EMS Non-Core ISO	Totals
Reporting	9	28	37
Non-Reporting	9	37	46

While the basic characteristics and management experience of reporting and non-reporting facilities were strikingly similar, however, several differences were evident in baseline regulatory performance. These differences suggest that the update facilities may have had less impressive regulatory performance during their baseline periods.

Specifically, facilities that reported during the update period were less likely to have experienced changes in regulatory status during their baseline period, though almost all of the update facilities (97 percent) had at least one regulatory requirement during the same period ($p \leq 0.10$). These facilities did not appear to be less stringently regulated than non-reporting facilities. In fact, the number of permitted emissions observed for update facilities during the baseline period was greater than the number observed for non-reporting facilities ($p \leq 0.10$); and increases in permitted emissions were more frequently observed for update facilities at some point during their baseline period ($p \leq 0.10$). While there was no difference between the number of reporting and non-reporting facilities for which a non-compliance or potential non-compliance was reported during the baseline period, prior violations had been more frequently observed at update facilities ($p \leq 0.10$). Table X-3 highlights these differences.

TABLE X-3: REGULATORY COMPLIANCE DIFFERENCES BETWEEN UPDATE AND NON-UPDATE FACILITIES

Update Status	Regulatory Status Change	Mean number of Permitted Emissions	Increased emission levels observed	Violations observed
Reporting	28%	17	94%	43%
Non-Reporting	48%	8	74%	22%

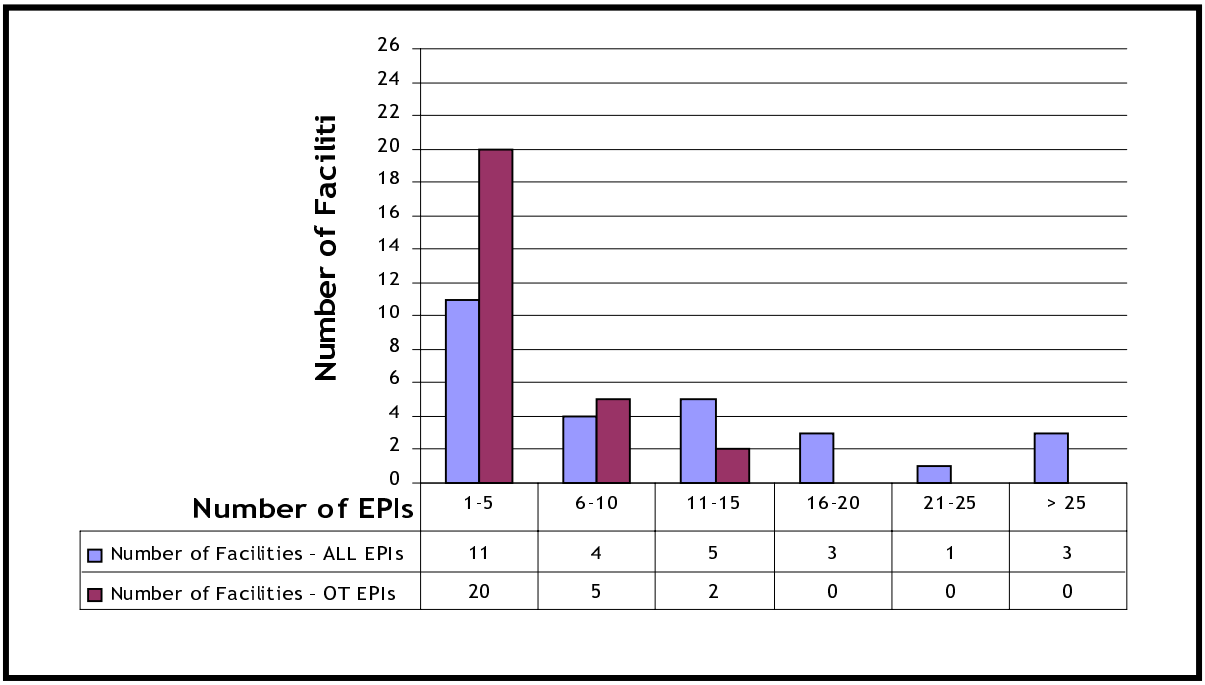
Environmental Performance Results – Indicators

The majority of update facilities (84 percent) had identified indicators of environmental performance during or prior to their baseline periods. Of these 31 facilities, 87 percent (27 facilities) reported update data for a total of 350 environmental indicators. Indicators from seven categories – materials use, sustainability & recycling, wastewater production & quality, air releases, waste generation & disposal, natural resource use, and spills & releases – were represented in the update data. Almost all of the update facilities (96 percent) tracked at least one indicator of waste generation and disposal from the baseline to the update period. More than half of these facilities monitored sustainability or recycling indicators (52 percent), natural resource use (52 percent), wastewater generation and air releases (63 percent for each) throughout the study period. However, more than half of these facilities (56 percent) tracked fewer than 10 EPIs, and two facilities accounted for more than one-third of all reported EPIs (112 indicators).

Forty-four percent of EPIs showed no change in the update period. There was some variability in performance outcomes, as illustrated by the smaller proportion of improved EPIs (38 percent) and a few EPIs (18 percent) that displayed deterioration in performance.

Thirty-four percent of the indicators (120 indicators) were identifiably related to the facilities' objectives and targets. The proportion of objective- and target-related EPIs that improved (42.5 percent) was identical to the number of EPIs that showed no change during the update period; a small proportion of EPIs related to objective and targets exhibited deteriorated performance (15 percent). Most facilities (77 percent) tracked five or fewer EPIs that were recognizably related to facility objectives and targets. Figure X-2 shows the range of EPIs tracked and the number of facilities that were in each range.

In order to compare performance outcomes, the results of the EPI analyses were aggregated to the facility level. Figure X-3 graphically presents each facility's performance score, represented by the green bars in the graphic below. Facility scores are ranked from highest to lowest and listed in the tables to the left of each graph along with the number of indicators evaluated. The proportion of all facility EPIs that were improved (green), unchanged (yellow) or deteriorated (red), is displayed for each facility in the top graph. The same performance key is used in the figure X-4 to illustrate EPI performance for indicators related to objectives and targets.



Number of EPIs	1-5	6-10	11-15	16-20	21-25	> 25
Number of Facilities - ALL EPIs	11	4	5	3	1	3
Number of Facilities - OT EPIs	20	5	2	0	0	0

Figure X-2: Number of EPIs Tracked by Facilities

The results reveal several trends in the data. First, almost half of the facilities (48 percent) had performance outcomes that included improvement and deterioration both, as well as unchanged performance. Second, for more than half of these facilities (56 percent) at least half of all indicators improved; an even greater proportion of facilities (63 percent) displayed this same trend when only EPIs related to objectives and targets were considered. Third, facilities that tracked more than 10 EPIs showed lower performance scores than facilities that tracked fewer than 10 EPIs ($p \leq 0.01$). In addition, fewer facilities had at least one deteriorated indicator when only indicators related to objectives and targets (30 percent) were considered, compared to 56 percent when all indicators were considered. These observations suggest that environmental performance is more impressive for indicators that have been singled out for priority through the EMS process. However, a comparison of overall performance results for indicators related to objectives and targets and indicators not related to objectives and targets revealed no statistically significant difference in performance outcomes.

The trends revealed in these data shed some light on the propositions suggested by prior research. First we must consider what outcomes – at minimum – one might expect to observe in these data if this suggestion is to be supported. First, one might expect the majority of outcomes to fall within the expected range of indicator values (e.g., relatively few improved or deteriorated outcomes). Second, this pattern should be consistent across all facilities. These data reveal that the majority of indicators (56 percent) were outside the range of expected outcomes (e.g., update values were either better or worse than prior data suggest). Further, when these data were aggregated to the facility level, the proportion of observed EPI values that were outside this expected range of outcomes was greater than 50 percent for nearly three-

quarters of the facilities.[81] These results provide some evidence that the introduction of an EMS does make an observable difference to a facility's environmental performance outcomes.

ID	Score	n
17	1.00	6
14	1.00	3
1	1.00	2
3	1.00	2
11	0.75	8
6	0.75	4
19	0.67	3
20	0.64	11
23	0.60	5
16	0.60	5
26	0.56	9
4	0.53	17
18	0.50	4
24	0.50	4
12	0.50	2
7	0.46	11
21	0.45	9
27	0.42	17
5	0.38	24
8	0.34	65
10	0.31	29
9	0.26	47
13	0.23	13
25	0.20	15
22	0.15	13
2	0.00	4
15	0.00	17

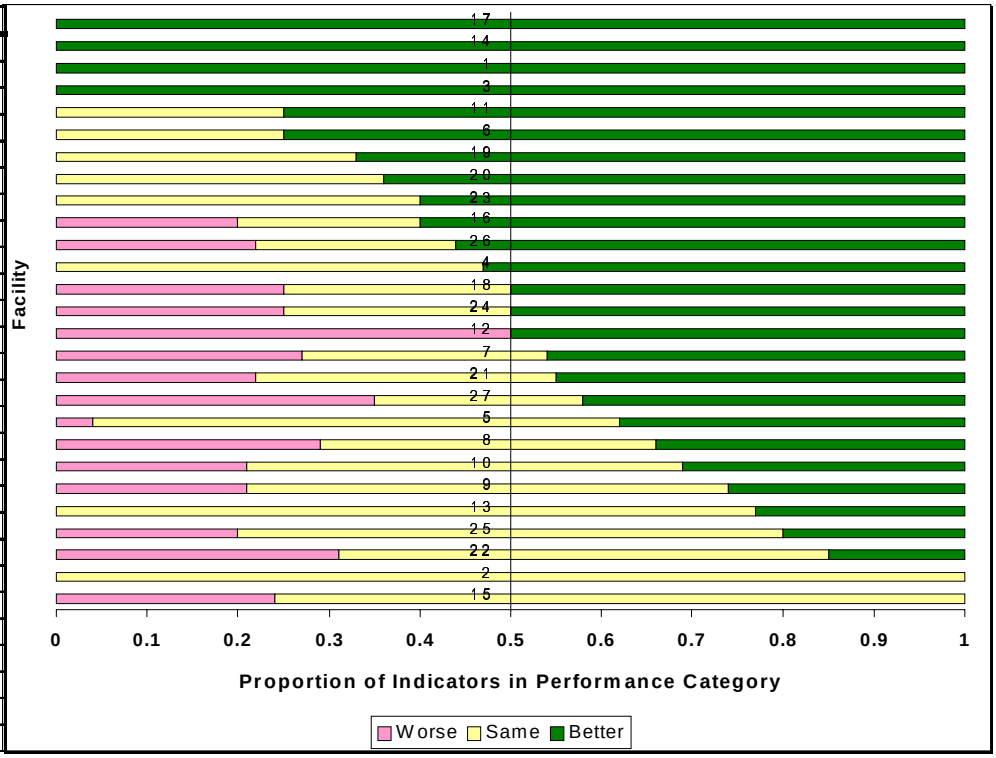


Figure X-3: EPI Results by Facility for All Indicators.

An alternative proposition that emerges from the literature is that the introduction of an EMS may be associated with improvements in environmental performance. In order to offer support to this proposition, we would expect to find that the majority of observed changes in EPI outcomes exceed baseline expectations of indicator performance. Second, we would expect this pattern to hold across these facilities. The results of our analysis meet these expectations and offer some support for this idea. The majority of EPIs for which a change in performance outcome was observed showed improvement (68 percent). Moreover, indicator performance outcomes that were better than the best baseline performance was observed in at least half of facility indicators for a majority of these facilities (56 percent).

Finally, prior research suggests the possibility that introduction of an EMS could be associated with worse environmental performance. While the results suggest that some deterioration in EPI performance may occur after EMS adoption – 56 percent of these facilities had at least one performance outcome that was worse than might be expected – in this analysis only 18 percent of the EPIs examined exhibited worse performance outcomes compared to baseline values. Furthermore, only one facility was observed to have worse performance outcomes in

[81] The proportion of EPIs that were unchanged during the update period was 50 percent or greater for only seven facilities in the NDEMS study.

at least 50 percent of indicators monitored. On the whole, these results do not provide support for this proposition.

ID	Score	n
17	1	4
11	1	4
23	1	2
1	1	2
19	1	1
18	1	1
14	1	1
3	1	1
20	0.8	5
6	0.75	4
26	0.56	9
4	0.57	14
24	0.5	4
21	0.5	2
16	0.5	2
10	0.5	2
12	0.5	2
27	0.39	13
5	0.33	3
22	0.25	4
25	0.17	6
2	0	3
7	0	1
13	0	8
8	0	10
15	0	10
9	0	2

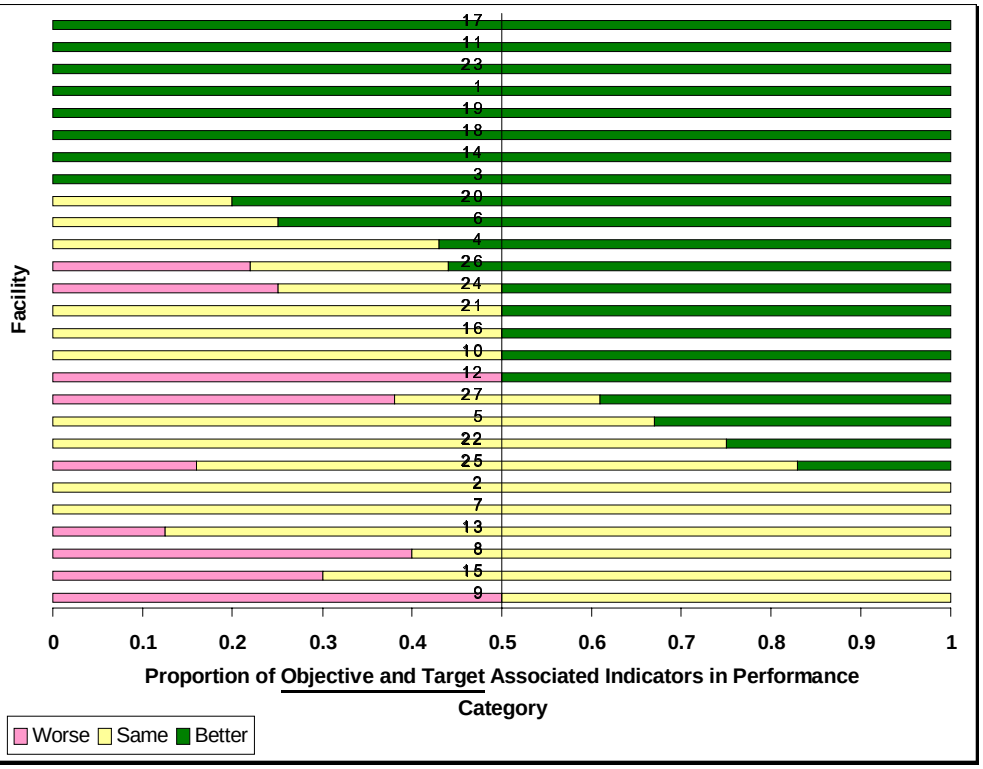


Figure X-4: EPI Results Associated with Objectives and Targets by Facility

TABLE X-4: SUMMARY OF FINDINGS

Proposition	Evidence Offered
Introducing an EMS makes no observable difference to a facility's environmental performance.	NO
Introducing an EMS is associated with improvements in environmental performance	YES
Introducing an EMS is associated with worse environmental performance	NO

Explaining Differences in Environmental Performance

While the results of our evaluation of environmental indicator performance suggest improvement on the whole, it is clear that some facilities performed better or worse than others. One variable of particular relevance that emerges in light of prior research is whether or not a facility intends to certify their EMS to the ISO standard and in the course of doing so employ third party auditors. ISO 14001 certification has in fact been the key variable used to differentiate facilities in each of the major studies that attempted to evaluate environmental performance. What has been more difficult to account for is the performance of those facilities that design and implement an EMS but do not elect to have the system externally verified.

The decision to seek third-party auditing and ISO registration, not simply to adopt an EMS, could further enhance environmental performance by adding the extra pressure of external scrutiny and questioning by independent professionals. It is not yet clear, however, how rigorous or even how consistent the professional norms of such auditors will prove to be. The ISO standards are open to diverse interpretation and judgment on key points, and evidence suggests that different auditors do in fact interpret them in varied ways (NAPA 2001, Ammenberg 2001). Like financial auditors, EMS auditors also face conflicting pressures between the ideals of environmental professionals and their necessary financial interest in obtaining and retaining business relationships with the audited firms. If they take an excessively permissive stance their credibility may be poor, but a highly rigorous position may cause them to lose business to more accommodating competitors (NAPA 2001).

Data provided during the EMS design phase of NDEMS data collection gives us the unique opportunity to explore this possibility. Facilities were asked to indicate whether they had certified or intended to certify their EMS to ISO 14001. Because certification of the EMS to ISO 14001 does not necessarily indicate that the facility will *register* that certification with an independent registrar, NDEMS participants were also asked to indicated whether the EMS was currently or would be audited in the future by an external third party. These responses were evaluated and coded 1 if the facility indicated both an intention to certify their EMS to ISO 14001 and an intention to have a third party audit their EMS, and 0 if otherwise.

The majority of these facilities (59 percent) intended both to certify their facility EMS to ISO 14001 and to use a third party to audit their system. Four facilities intended to certify their EMS, but did not currently use or intend to use third party auditors. Four other facilities were currently audited by a third party but had no intention to certify. The remaining three facilities had no intention of either ISO 14001 certification or third party auditing of their facility EMS. The mean EIPI scores of these groups with differing intentions are presented in Table X-5.

TABLE X-5: ISO CERTIFICATION AND THIRD PARTY AUDITOR INFLUENCE ON EPI PERFORMANCE SCORES

	YES		NO	
Variable	***n***	***EIPI Score***	***n***	***EIPI Score***
ISO certified or intends to certify EMS	20	.510	7	.509
3rd party audit or intends to use 3rd party audit of EMS	20	.524	7	.468
Both	16	.528	11	.483
Neither	3	.510	24	.510

The mean performance score of the sixteen facilities that were certifying their EMS to ISO 14001 and utilizing third-party auditors (x=0.53) was not statistically different from the eleven facilities planning to do neither or only to certify or use a third-party auditor (x=0.48). In fact, scores between auditing (x=0.52) and non-auditing facilities (x=0.47) as well as scores between facilities certifying to ISO 14001 (x=0.51) and those with no certification intentions (x=0.51) were statistically equal. A lack of statistically significant differences between the EIPI scores of facilities with intentions to certify and utilize third-party auditors and those without such plans sheds little light on the variation in performance that we have observed and suggests that outside evaluation and certification of the EMS adds little to the performance

potential of the adopting facilities.[82] These results also suggest that the EMSs in general – whether certified to the ISO14001 model or not – may produce improvement in environmental performance.

If facilities that do not intend to use third party evaluation and/or certification of their EMSs perform as well on their selected environmental performance indicators as those that do, what other considerations might account for variability in performance outcomes? Certainly the performance effects of an EMS may vary depending on the organization's motivation and goals in adopting an EMS. For instance, a facility that introduces an EMS as a tool to improve the overall efficiency of its use of materials and energy – or to improve its management processes more generally – may well achieve greater improvement in environmental performance outcomes than one that uses it merely to satisfy a customer mandate that it have a certified EMS in place, or one that wants certification merely to promote its public image.

Similarly those organizations that have established a culture of concern for environmental issues through adoption of prior programs – such as pollution prevention or participation in an environmental VEI – may transfer these values more effectively to their employees via the EMS training and monitoring requirements as individuals are more likely to engage in environmentally conscious behaviors and adopt environmentally friendly attitudes when others around them do so as well (Van Raaij, 1998). The facility adopting an EMS due to these internal motivations might improve overall environmental performance through increased awareness and internalization of environmental concern by the individual (Van Raaij, 1998) employee in their daily tasks.

One framework developed to investigate facility motivations for EMS adoption suggests that pressures from the regulatory regime, market forces and societal expectations; as well as internal capabilities developed by the facility from prior continual improvement and environmental management motivate participation in proactive environmental management strategies such as EMS (Darnall, 2002).[83] This work further suggests that these motivating factors differentially influence facilities owned by publicly traded, privately held, and governmental organizations. Environmental outcomes were examined for variation in performance scores associated with these external and internal driver variables. The following external drivers were evaluated:

1) Market Drivers
2) Regulatory Drivers
3) Societal Drivers

[82] It is possible, however, that the first update data were collected too soon to provide clear evidence one way or the other, since they were generally less than a year after introduction of the EMS and in many cases any intended certification had not yet occurred. Longer-term tracking of performance indicators would be necessary to develop definitive evidence for or against this hypothesis.

[83] See Chapter 6 for reference of original work and a thorough discussion of the theoretical background supporting this model.

Because convincing evidence has been presented to suggest that facility ownership is an appropriate proxy for prior internal capabilities throughout this report,[84] environmental performance outcomes were evaluated based on whether the facility is owned by:

4) A publicly traded organization
5) A privately held organization
6) A government institution

The correlation between rating of each motivator considered[85] and the facility EIPI scores are presented in Table X-6. These results show a number of statistically significant associations between environmental performance outcomes and market as well as regulatory drivers. The correlation between internal capabilities and performance outcomes was also statistically significant. There were no significant associations between EIPI scores and social motivators.

More specifically, as a facility's consideration of marketing potential increased, so too did the proportion of baseline EPIs that improved during the first update period. However, no statistical difference was found between EIPI scores at facilities that rated the potential for EMS adoption to be used as a marketing tool as a high or medium influence on their adoption decision (x=0.58) when compared with facilities that rated this pressure low or did not consider the pressure at all (x=0.44).

Statistically significant correlations and differences in EIPI scores were found, nonetheless, between facilities that rated the influence of potential competitive advantages or increased revenues medium or high in their adoption decisions (x=0.59 and x=0.66, respectively) and those that did not consider these factors or rated their importance low (x=0.35 and x=0.41, respectively). Similarly, higher consideration of the support for EMS adoption by other professionals on the facility's adoption decision was also correlated with higher EIPI scores. Table X-7 presents the mean EIPI scores of facilities rating these factors either high or medium and EIPI scores of facilities that rated these factors low or did not consider them in their EMS adoption decisions.

While there was no correlation between the rated importance of regulatory considerations in EMS adoption decisions examined and EIPI scores, the occurrence of regulatory violations or non-compliances at a facility was negatively associated with EIPI scores. Lower EIPI scores were observed for facilities that reported at least one instance of a violation (x=0.38) or an instance of non-compliance (x=0.40) during their baseline period when compared to facilities without regulatory infractions (x=0.63 and x=0.58, respectively). Performance scores were strongly correlated with increasing levels of baseline capabilities as measured by facility ownership.

[84] See demographic results in Chapters 4 and 5, motivation analysis in Chapter 6, and cost analysis in Chapter 11.

[85] Facilities ranked the influence of these considerations in their EMS adoption decisions on a four point scale where 1=n/a, 2=low, 3=medium, 4=high.

TABLE X-6: ASSOCIATION OF EIPI SCORES AND EMS ADOPTION MOTIVATIONS

Adoption Motivations	Correlation with EIPI Score
External Motivator	
Market (n=27)	
Domestic customer pressure to adopt	0.24
International customer pressure to adopt	0.21
Use of EMS as a marketing tool	0.38**
Potential competitive advantage from adoption	0.51***
Professional support for EMS adoption	0.32*
Shareholders/owner pressure	0.20
Cost reduction	-0.12
Increased revenues	0.48***
Regulatory (n=27)	
Baseline violations observed[a]	-0.47***
Baseline non-compliances observed[b]	-0.34*
Potential for improved compliance from EMS adoption	0.13
Possible regulatory benefits from EMS adoption	-0.16
Availability of government assistance	-0.29
Social (n=27)	
Number of inquires from outside parties baseline[c]	0.13
Outside parties request for EMS adoption	0.21
Potential for EMS adoption as a public relations tool	-0.18
Internal Motivator	
Prior Capabilities (n=27)	
Ownership[d]	0.45**

* $p \leq 0.10$
** $p \leq 0.05$
***$p \leq 0.01$
[a] violations=1, no violations=0
[b] non-compliances=1, no non-compliance=0
[c] 0-1 inquires=1, 2-10 inquires=2, 11-50 inquires=3, 51-100 inquires=4, >100 inquires=5
[d] government=1, privately held=2, publicly traded=3

TABLE X-7: MEAN EIPI SCORES BY MOTIVATOR

Motivating Factor	MEAN EIPI SCORE				$p \leq X$
	n	***Rated Factor High***	***n***	***Rated Factor Low***	
Use of EMS as a marketing tool	13	0.58	14	0.44	0.13
Potential competitive advantage from adoption	18	0.59	9	0.35	0.06
Professional support for EMS adoption	10	0.66	17	0.44	0.06
Increased revenues	11	0.66	16	0.41	0.04
		Yes		***No***	
Baseline Violations observed	13	0.38	14	0.63	0.03
Baseline Non-compliance observed	11	0.40	16	0.58	0.10
		Publicly Traded		***Private/Government***	
Internal Capabilities	13	0.65	14	0.38	0.02

Indeed, publicly traded firms, with the strongest internal capabilities and greatest access to organizational resources, had higher EIPI scores (x=0.65) than did privately held and government facilities (x=0.38) with their more modest experience and resources.

Indeed differences in facility motivations appear associated with better or worse performance outcomes in that higher environmental performance outcomes were observed between facilities with higher market-driven motivators and those facilities less influenced by these forces, and between facilities without past compliance infractions and therefore less explicit motivation to improve regulatory compliance. Better performance outcomes also were observed between facilities which, due to prior implementation of continual improvement and environmental management programs, may have developed internal motivation for EMS adoption and those with more meager internal capabilities.

Conclusions – Environmental Performance

This investigation of environmental performance outcomes is an important step in the confirmation of results from case-study reports and other survey instruments that show improved performance in facility-reported environmental indicators after EMS adoption. These results provide the strongest support to date for the proposition that EMS adoption positively affects environmental performance over time and across a variety of environmental indicators and business sectors. These results also begin to shed some light on which factors might be associated with more impressive environmental performance outcomes, by illuminating the achievements of facilities with market based motivation for EMS adoption and strong internal management capabilities prior to EMS development. Finally, these results highlight the importance of a strong record of prior compliance with regulatory requirements in future environmental performance outcomes.

REGULATORY COMPLIANCE

We now turn our attention to the topic of how EMS adoption may affect regulatory compliance. In the United States, regulatory compliance has been the most basic indicator of environmental performance used for the past three decades, and the primary preoccupation of environmental management staff. The ISO 14001 EMS standard requires an explicit commitment to achieving compliance with all applicable regulations; and inherent in the EMS process is the production of more detailed and explicit documentation tracking compliance outcomes. There is every reason to expect, therefore, that the introduction of an EMS will focus even greater scrutiny on compliance as a principal measure of environmental performance, whatever other indicators are used.

That said, however, an EMS might make no observable difference in outcomes because a facility was already doing all it could or was prepared to do to improve its compliance.[86] In addition, the time frame of this study might be too short to observe significant changes in outcomes.[87] Or an EMS might in fact improve compliance, due to the EMS's more explicit tracking and documentation of it and to the broadening of responsibility for it to all managers and employees rather than just the EHS staff. Alternatively, its compliance in the short term after an EMS is introduced might appear to worsen, as the more explicit tracking procedures of the EMS identified (and potentially corrected) more non-compliances that previously went undetected. Similar lines of reasoning might apply to the potential effects of third-party auditing and ISO registration, and to the variability of results depending on motivation.

Data for this evaluation consists of reports from the 37 facilities that submitted update data to NDEMS and reported data on violations and non-compliances for both the baseline and update periods. Several measures of regulatory compliance were assessed using these data:

Violations

First, the data were evaluated to determine whether or not violations had occurred at the facility during the baseline period and during the update period. Each reporting period was evaluated and coded independently. If a major violation was observed during a reporting period, the facility was coded "1" for major violations, "0" for no major violations. Minor violations were evaluated similarly. Because so few violations classified as major were observed in this sample,[88] an aggregate variable was constructed and coded for each reporting period – "1" for any reported violations, "0" for no reported violations.

The total number of major and of minor violations observed during the update and baseline periods was tallied for each facility. The totals from the update period were compared to those

[86] This outcome is particularly plausible in the present study, in which the facilities were all volunteers working in cooperation both with the researchers and with their state environmental agencies (some of the states excluded facilities with major recent violations from participation in the study).

[87] Many routine compliance data, such as air emissions and wastewater discharges, are self-reported on a regular basis (e.g. quarterly), but data on actual violations are more variable and often are not recorded until a facility is inspected. For many facilities, such inspections may occur only once every several years, thus making it difficult to determine in the short term whether or not a facility truly has changed its compliance pattern after implementing an EMS.

[88] Only 1 facility in this sample reported a major violation during the baseline and update periods; one additional facility had a major violation during the update. All other violations were classified as minor.

from the baseline in order to determine whether the *frequency* of violations at the facility was changed. In order to measure the *severity* of observed violations, the total amount of fines that resulted from observed NOVs was also totaled for both the baseline and design periods. The totals were compared to determine whether the severity of violations had increased or decreased. To add some context to the data described above, facilities were also asked to provide data on the manner in which the violation was discovered, the factors that may have led to the violation, and corrective actions taken to remedy the infraction.

Non-Compliances

Since non-compliances and potential non-compliances are similar in nature to violations, reports of regulatory issues defined as non-compliance and potential non-compliances were evaluated using the same methods as described above.[89]

Statistical Methods and Techniques

Since certain assumptions made with standard statistical tests cannot be made about our sample (e.g., normality of distribution), non-parametric methods were used to test differences between performance outcomes and to make comparisons between groups.[90] A number of tests were used in this evaluation:

a) The *Wilcoxon signed-rank test* was used to compare differences between continuous dependent variables in before-after comparisons (e.g., differences in the number of violations, non-compliances and potential non-compliances as well as the amount of fines between reporting periods).

b) *McNemar's symmetry chi-square* was used to test differences between dichotomous or categorical variables in before-after comparisons (e.g., differences in the numbers of facilities reporting violations, non-compliances and potential non-compliances).

c) *Fisher's exact test* was used to determine differences between dichotomous or categorical variables in independent samples (e.g., differences between facilities that eliminated regulatory compliance issues and those that did not).

d) *The Wilcoxon rank sum test* was used to determine differences between continuous dependent variables in independent samples (e.g., differences in motivation ratings at facilities that eliminated NOVs versus facilities that did not).

Results

Most NDEMS facilities reported data on regulatory compliance during the baseline and update periods. The demographic composition of these 35 facilities was reported earlier in this

[89] One exception involves the evaluation of fines associated with compliance issues. Facilities were not asked to provide data on penalties assessed for non-compliances and potential non-compliances, since incidents of these sorts are considered less serious forms of regulatory non-conformance and state or federal regulators do not typically impose fines when these situations are discovered.

[90] Non-parametric tests necessarily do not make the standard assumptions that define their parametric counterparts (t-test, Pearson correlation coefficient, etc.), and therefore produce highly conservative *p*-values. For this reason, more liberal levels of significance ($p < 0.10$) are sometimes considered acceptable, in addition to conventional levels ($p < 0.05$) (Kahn and Goldenberg 1991).

chapter in our discussion of the representativeness of the update facilities compared to the larger NDEMS sample and are not presented again in this section. Instead we examine the regulatory compliance performance of these facilities during each reporting period in more detail.

Nearly half (fifteen facilities) had reported a violation of regulatory requirements during the baseline period, comprising a total of 86 official notices of violations (NOVs) issued to these facilities. Five facilities (14 percent) had been fined due to violations during the baseline period, for a total of $12,227. Although just two facilities had accounted for half of all observed violations, these data were representative of the baseline frequencies of violations, identification, causes and corrections of non-conformance at the facility level. At most facilities two or more violations had been observed and at 90 percent of the facilities at least one violation had been discovered by regulatory inspections or operating procedures. Most violations had been discovered by regulatory inspections or by routine operating procedures that were in place at the facility during the reporting period. The causes of violations and subsequent corrective actions were widely dispersed across the facilities with no single category observed at more than half of the reporting facilities.

Non-compliances had been observed with greater frequency at these reporting facilities when compared with violations. All together, 127 non-compliances had been observed at fourteen facilities. Three facilities, however, accounted for approximately 80 percent of these observations; most facilities (79 percent) had had fewer than the average (nine) non-compliances.

On the whole, there was no statistical difference between the observed numbers of violations, non-compliances or fines at these facilities during these two reporting periods. Eighty-six total violations had been reported during the baseline period, and a slightly higher number (88) was reported during the update. Non-compliance observations also were statistically similar (127 baseline, 116 update), as was the difference in fines levied by regulators at each facility between the baseline and update periods (mean difference = $587, standard deviation $2,476).[91] Comparing by the number of facilities reporting non-compliances, the results were also similar – 14 during baseline, 12 during update – as were the numbers of facilities reporting fines (five facilities and three facilities, respectively).

The number of facilities at which a violation was observed did differ statistically from the baseline to the update period ($p \leq 0.01$). During their baseline period, fifteen facilities reported at least one instance of a regulatory non-conformance that led to a NOV by the regulating body. After EMS introduction, occurrences of the same type were observed at only six facilities. Figure X-4 illustrates the changes in reported violations at the facility level from the baseline to the update period.

[91] T-test for dependent samples was used in this assessment.

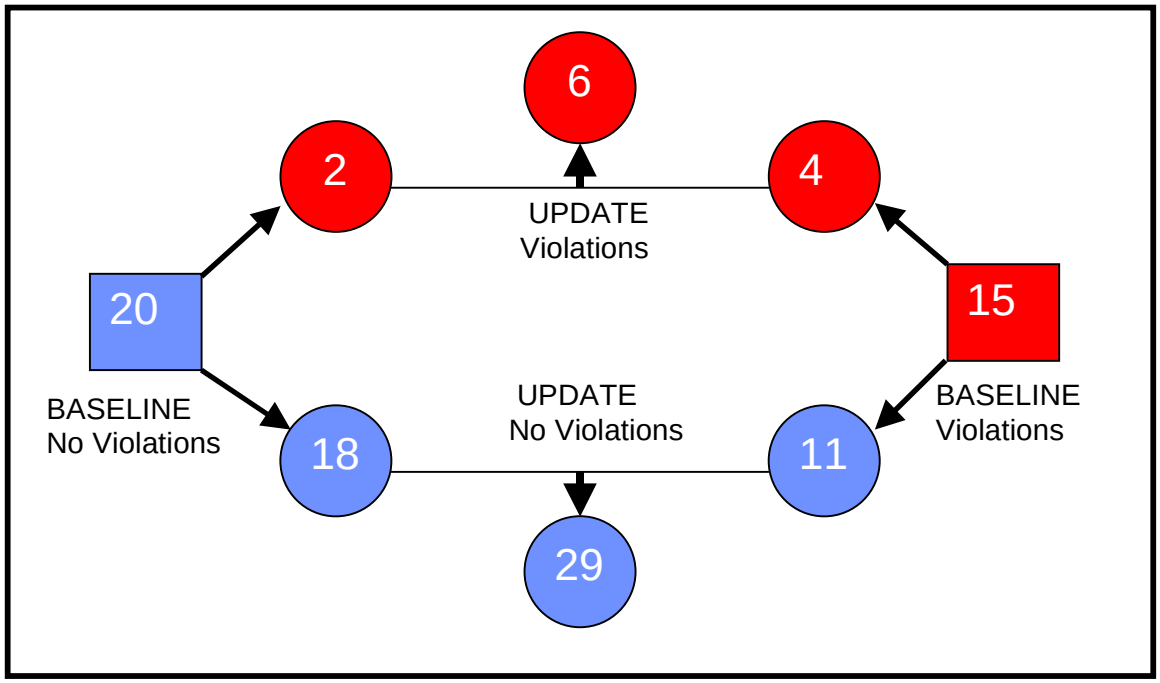


Figure X-4: Changes in Observed Violations after EMS Introduction.

There is substantial evidence to suggest that introduction of an EMS had little effect on regulatory compliance at the facility level on the whole. Though a substantial number of facilities eliminated violations after EMS implementation – which suggests that introduction of an EMS at the facility improves regulatory performance to some degree – this is not a surprising result given that nearly all violations reported by these facilities were minor and likely included many of the sorts of paperwork and procedure violations which an EMS might be expected to improve. A lack of evidence that demonstrates statistically significant improvement in the number of non-compliances observed and the amount of regulatory fines reported limits our ability to make a stronger statement on the effectiveness of EMS to improve regulatory compliance. Furthermore, there was little evidence to suggest negative compliance outcomes as a result of EMS implementation at these facilities.

Explaining Differences in Regulatory Compliance

Though little evidence was found in the analysis of the NDEMS sample to support any significant change in regulatory compliance outcomes, the fact that many facilities eliminated NOVs at their sites after EMS implementation is an important accomplishment. Comments on a preliminary presentation of our work, however, suggested that this examination of changes in reported violations should also be viewed in relation to inspection activity. More precisely, whether or not the facility was inspected should be considered in instances where observed violations were zero. To address this concern, inspection data were collected for each facility in this analysis using data contained in EPA's OTIS inspection database and from a number of state regulatory bodies. Facilities that reported zero violations but had not been inspected during the relevant time period were removed from consideration. The results of McNemar's test for dependent samples was still significant ($p \leq 0.10$) which supports the initial findings.

To understand what factors may be responsible for compliance improvements within this sample of EMS adopters, the group of facilities which eliminated violations at their sites during the update period were compared to facilities that did not in light their certification intentions and adoptions motivations.

Eleven facilities that reported NOVs at their site during the baseline period eliminated these regulatory non-conformances during the update period (these facilities are referred to as the "improved" facilities hereafter). These facilities were compared to the six facilities that either did not eliminate baseline violations or were issued a NOV during the update period (these facilities are referred to as the "unimproved" facilities). Table X-9 shows the results of this investigation and suggests ISO auditing and certification or intentions to pursue them made no observable difference to compliance outcomes.

TABLE X-9: ISO CERTIFICATION AND AUDIT INTENTIONS OF IMPROVED AND UNIMPROVED FACILITIES

Variable	**Yes**		**No**	
Group	***Improved***	***Unimproved***	***Improved***	***Unimproved***
ISO Certified/Intends to certify	64%	67%	36%	33%
Third Party Audit/Intends to Use Third Party	73%	67%	27%	33%
Both	45%	33%	55%	67%
Neither	9%	0%	91%	100%

Motivations of improved and unimproved facilities were examined using a similar framework as identified earlier in this chapter. The mean rating of each motivator was compared between groups, and the results are shown in Table X-10. Data for internal motivation (using ownership as proxy) are displayed in Table X-11.

TABLE X-10: ASSOCIATION OF EMS ADOPTION MOTIVATIONS AND IMPROVED REGULATORY COMPLIANCE

External Motivator	Mean Rating: Improved Facilities	Mean Rating: Unimproved Facilities
n=	***11***	***6***
Market		
Domestic customer pressure to adopt	2.17**	1.20
International customer pressure to adopt	1.90*	1.20
Use of EMS as a marketing tool	2.58*	1.80
Potential competitive advantage from adoption	3.00*	1.80
Professional support for EMS adoption	2.33	1.60
Shareholder/owner pressure	2.00*	1.20
Cost reduction	3.50	3.00
Increased revenues	2.17	1.80
Regulatory		
Potential for improved compliance from EMS adoption	3.25	3.40
Possible regulatory benefits from EMS adoption	2.83	3.00
Availability of government assistance	2.33	3.20
Social		
Number of inquiries from outside parties	3.25	3.40
Outside parties' request for EMS adoption	1.42	1.40
Potential for EMS adoption as a public relations tool [a]	2.92	2.80

* $p \leq 0.10$
** $p \leq 0.05$
***$p \leq 0.01$
[a] 0-1 inquiries=1, 2-10 inquiries=2, 11-50 inquiries=3, 51-100 inquiries=4, >100 inquiries=5

Of the external motivators, statistically significant ratings of adoption motivations were evident only for those factors that represented market forces. In each case, improved facilities rated the influence of market considerations higher than did unimproved facilities. Improved facilities rated the influence of domestic customers, international customers, use of EMS as a marketing tool, pressure from shareholders or owners, and potential for competitive advantage higher in each instance than did unimproved facilities. These results are not surprising when one considers the market positioning of these two groups. More than two-thirds of the unimproved facilities were government installations, which by their nature tend to operate outside of market forces. In contrast, all eleven of the improved facilities were publicly traded or privately held firms, while only two of the four unimproved facilities operated under the influence of market forces.[92] These forces are likely to reward companies that reduce their violations, due to reductions in perceived environmental liability that may result from a clear

[92] See Chapter 2 and Darnall (2002) for a more in-depth discussion of the opposing economic forces that act on these various organizational types.

regulatory record. Many have speculated that reductions in such risks may reduce insurance premiums or provide other economic benefits for facilities adopting EMSs.

TABLE X-11: TABLE OF COMPLIANCE OUTCOMES BY OWNERSHIP

Owner	Publicly Traded	Privately Held	Government
Improved Compliance	4	7	0
Unimproved Compliance	2	0	4

As Table X-11 illustrates, the difference in ownership between improved facilities and unimproved facilities is stark ($p \leq 0.001$). These results muddle the picture somewhat as we have found that government facilities, in addition to being insulated from larger market forces, also are consistently deficient in the internal resources that have enabled business facilities to adopt EMSs (Darnall 2002) and that also may allow facilities to improve overall environmental performance (as we saw earlier, in our investigation of EPI outcomes). The high number of privately held firms that improved their regulatory performance suggests a stronger role for the market-based argument, as these facilities are expected to have developed internal management strategies that fall somewhat between the high end (publicly traded firms) and low end (government installations) of the spectrum (Darnall 2002). Further research is needed however, to understand this relationship more clearly as it pertains to improved regulatory compliance outcomes.[93]

Conclusion

Our investigation of regulatory compliance outcomes suggests that there is apt to be some positive impact on compliance as a result of the introduction of a facility EMS. These results are tempered somewhat, however, by a larger body of evidence growing out of these results that suggested few changes in either the frequency or occurrence of non-compliances. Further, introduction of an EMS had little influence on the number and severity of fines levied for regulatory non-conformance. Facilities that did improve their regulatory compliance (e.g., eliminated NOVs) were primarily motivated to adopt their EMS either by external market forces or by internally-developed management capabilities. While not conclusive, these results tend to support the market-based argument.

[93] Additional research may be especially valuable since publicly traded firms are expected to have greater internal capabilities than are privately held firms, yet the facilities owned by publicly traded organizations did not display such a clear pattern of improvement.

Chapter 11. The Costs of EMS Adoption: Do Organizations Differ?[94]

INTRODUCTION

Since December 1995, when the International Organization for Standardization (ISO) designed its environmental management system (EMS) standard, ISO 14000, EMSs have gained increasing attention. Enterprises that adopt an EMS systematically consider their impact to the natural environment by developing an environmental policy, evaluating their internal processes that affect the environment, creating objectives and targets, monitoring progress and obtaining management review. In the U.S. alone, more than 950 facilities certified their EMSs to ISO 14001 by 2000, and many more have adopted non-certified EMSs (Darnall, 2001). These organizations have developed their EMSs in response to external pressures from the market, regulators and society as a whole, and have extended their proficiencies in environmental management (Darnall 2001, 2003) helping them to potentially achieve competitive advantage.

Interest in EMSs extends beyond the organizations that adopt them. In recent years, environmental regulators have also turned to EMSs with the hopes that these systems may be useful to achieving their environmental goals. As recently as May 2002, the U.S. Environmental Protection Agency (EPA) affirmed its commitment to using and promoting EMSs in the regulated community (U.S. EPA, 2002). Environmental regulators have also sponsored multiple voluntary environmental initiatives (VEIs) to encourage a wide array of organizations to adopt EMSs. These VEIs offer participants recognition and financial and technical aid.

Despite the increasing pace of EMS adoption and the growing endorsement by regulators, little is known about how the factors that predict the costs for different types of organizations to implement them. More importantly, prior research has not considered the link between an organization's internal competencies and how they might affect EMS adoption costs. Indeed, organizations with stronger internal capabilities may incur fewer costs than organizations with weaker internal capabilities, because they are more proficient with management techniques that may facilitate EMS design and implementation. Enterprises with stronger internal competencies are also more likely to have access to additional resources that mitigate their EMS adoption costs.

The lack of information is for several reasons. First, most organizations that have adopted EMSs are unwilling to disclose information about their design and implementation

[94] Nicole Darnall and Daniel Edwards, Jr. led the effort devoted to this chapter. It has been submitted for review and publication in Darnall, N. and Edwards, Jr., D. (2003), 'Predicting the costs of environmental management system adoption: a resource-based view,' *Strategic Management Journal*.

expenditures. Second, the few case studies that have begun to emerge largely focus on either specific industries (Mullin and Sissell, 1996; Berry and Rondinelli, 1998; Wall, Weersink and Swanton, 2001), facilities within a single organization (Moretz, 2000) or government entities (GETF, 2000). Other studies have considered a limited number of case enterprises in different types of industries (Prakash, 2000; Darnall, Gallagher and Andrews, 2001).

While these initial investigations have proven helpful to understanding the basic factors that may affect the costs of EMS design, they cannot make broader generalizations about their findings because of their limited focus and small sample sizes. Moreover, prior studies utilize different accounting systems to estimate EMS adoption costs, making cross comparisons a challenge. Yet, EMSs are being implemented within all types of enterprise—publicly traded, privately owned and government. As a result, little is known about how these organizational differences may affect EMS design costs or why some enterprises incur greater design costs than others.

This study addresses these issues by using a standardized process to compare the EMS design costs[95] for different types of organizations. Using theory articulated by the resource-based view of the firm (RBV), organizations' internal capabilities were evaluated for three organizational structures—publicly traded and privately owned organizations and government operations—to better understand their relationship with EMS design costs. Inferences were made about what types of enterprises were more likely to incur greater EMS adoption costs. These differences were then tested empirically using standardized EMS cost data for 42 facilities in the National Database of EMSs (NDEMS). The results showed that organizations' prior internal competencies predicted EMS design costs and that organizational structure also affected costs.

THEORY AND HYPOTHESES

RBV provides a framework for understanding how organizational structure affects EMS adoption costs. By recognizing how different types of organizations are structured it is possible to link these structural differences to the cost of EMS design.

The Resource-based View of the Firm and EMS Design

Resources are the basic units of analysis in RBV and include valuable tangible assets that an organization owns (McGuire, Sundren and Schneeweis, 1988; Lawrence and Morell, 1995; McGuire, Schneeweis and Branch, 1990). An organization's ability to deploy and coordinate its resources and put them to productive use gives rise to specific internal capabilities (Grant, 1991; Collis and Montgomery, 1995) that facilitate the development of more complex environmental management processes (Hart 1995; Russo and Fouts, 1997) and continual improvement (Hart, 1995). Organizational capabilities also include less tangible knowledge-based processes that are socially complex. For example, prior research suggests that organizations possessing prior management system capabilities, based on continual improvement processes, are more able to transfer their system-based knowledge towards adopting an EMS (Sarkis and Kitazawa, 2000). These organizations are also more proficient at

[95] Within the context of this study, "EMS Design" refers to the first full year of the EMS design and implementation process.

transferring tacit knowledge and generating momentum towards encouraging commitments in environmental management (Hart, 1995; Klassen, 2000) and achieving proactive environmental change (Florida, 1996; Lawrence and Morell, 1995; Darnall, Gallagher and Andrews, 2001; Andrews *et al.*, 2001; Darnall, *et al.*, 2000). All of these competencies assist enterprises in achieving greater organizational efficiency (Hart 1995; Lawrence and Morell 1995; Welford 1992; Mullin and Sissell 1996; Bergstrom 1996; Abarca 1998; Georgiadou and Tsiotras 1998) that lead to competitive advantage (Barney, 1991). Organizations that have developed their basic management system capabilities may thus more readily transfer their knowledge and generate momentum to adopt an EMS (Darnall, 2003), and at the same time reduce their EMS design costs.

In addition to basic management systems capabilities, prior experience with environmental management practices is expected to affect EMS design expenditures. For example, implementing a successful pollution prevention plan requires many employees to work together, sharing their tacit knowledge of the organization's internal operations in order to minimize impact to the environment (Hart, 1995). Organizations that have developed pollution prevention capabilities have invested in training their employees that can be readily applied towards more advanced forms of environmental management (Kunes, 2001; Hart, 1995, 1997; Darnall, 2003). Environmental management capabilities are thus path dependent in that they are a function of basic internal proficiencies and learning that accrue over a period of time (Hart, 1995). To attain a higher level of environmental competency, such as EMS adoption, organizations may first need to be expert in basic levels of environmental management, and acquire the socially complex or process-based resources to do so (Henriques and Sadorsky, 1996; Hart 1995; Russo and Fouts, 1997; Darnall, 2001, 2002).

Similarly, enterprises that posses these basic capabilities may also reduce the costs of EMS design, because they already have a basic environmental management structure in place that may be extended to support the organization-wide commitments required to adopt an EMS. These competencies may also lead to competitive advantage (Christman, 2000).

Finally, an organization's environmental management capabilities depend on its ability to allocate resources towards developing basic strategic competencies (Aragon-Correa, 1998; Arora and Cason, 1996; Russo and Fouts, 1997). Organizations that operate efficiently allocate their resources towards achieving increased operational effectiveness (Browning and Browning, 1992), thus creating slack. Slack allows an organization to pursue innovative projects because they buffer it from the uncertain success of these projects, thus fostering a culture of experimentation (Bowen, 2000). These resources serve as a foundation upon which more complex environmental management practices can emerge (Waddock and Graves, 1997; Bowen, 2000; Lawrence and Morell, 1995; McGuire, Schneeweis and Branch, 1990; McGuire, Sundren and Schneeweis, 1988; Hart, 1995). More specifically, managers that possess greater levels of discretionary slack (Sharma, 2000) have a greater ability to attempt costly or risky environmental investments (Ahmed, Montagno and Firenze, 1998; Henriques and Sadorsky, 1996) and may thus rely on these internal resources when adopting an EMS.

In contrast, organizations lacking resource slack may be more likely to seek support either from other operational units within the enterprise or from external sources. Organizational units may, for example, share financial resources, (Bowen, 2000) technical assistance (Darnall, 2003) or knowledge of management processes between the parent enterprise, sister facilities and within divisions to increase environmental expertise (Wernerfelt, 1984; Grant

1991; Russo and Fouts, 1997; Collis and Montgomery, 1997; Barney, 1991). Resources for EMS design may also accrue from external sources, such as government funded grants and technical support. These external resources may be used to fortify an organization's otherwise lacking internal capacities (Darnall, 2003), making EMS adoption less costly. Enterprises may also rely on assistance from external consultants to bolster their less robust internal proficiencies, thus making EMS design possible.

Management system capabilities, environmental management expertise and access to resources therefore provide a basis to evaluate organizations' EMS design costs. Figure 1 summarizes these relationships.

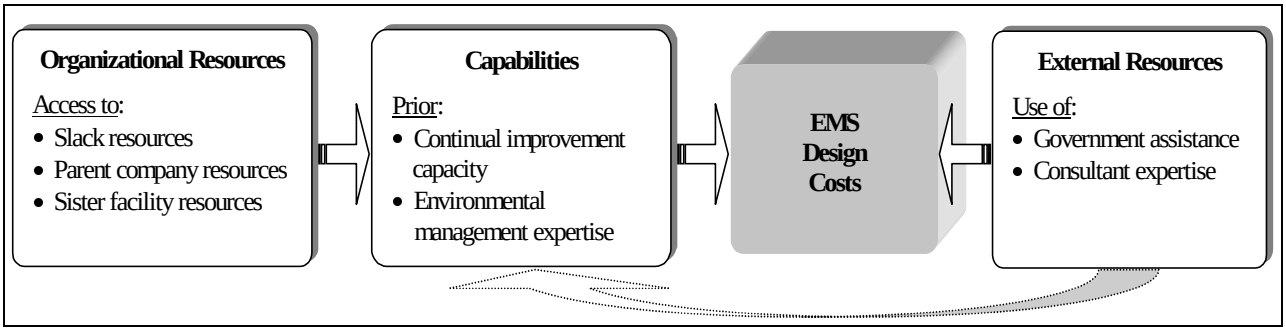


Figure XI-1: Relationship between Resources, Capabilities & EMS Design Costs

However, not all types of organizations are expected to have similar internal capabilities or access to the resources that facilitate EMS adoption. In fact there may be significant differences among organizations that pursue for-profit goals—both publicly traded and privately owned—and government enterprise (Darnall, 2003). It is thus important to address how resources and capabilities differ among these types of organizations to understand how their costs for EMS design might also differ.

RBV AND ORGANIZATIONAL STRUCTURES[96]

While many enterprises are choosing to adopt EMSs, an important distinction is that some are for-profit organizations (both publicly traded and privately owned) while others are government organizations (Darnall, 2003). These distinctions may affect their internal capacities and access to resources (Darnall, 2003), and their cost of designing and implementing an EMS.

Both publicly traded and privately owned organizations operate with profit seeking goals. As resources enter into both types of organizations they are allocated towards achieving operational efficiency (Miller, 1992). Despite their common goal, publicly traded operations generally have more market share because they are larger than private businesses. This organizational structure affords many publicly traded organizations greater access to financial resources that can be used to develop their internal environmental expertise (Bowen, 2000;

[96] The discussion presented in the following sections is a general summary of how publicly traded, privately owned and government organizations differ. It is not intended to be exhaustive and considers the *average* enterprise for each type of organization.

Russo and Fouts, 1997; Greening and Gray, 1994). Such resources are often shared between parent corporations and their operational units (Bowen, 2000) to achieve greater economies of scale.

The owners of publicly traded organizations are shareholders. These individuals are generally large in number and widely dispersed. Because shareholders are relatively uninformed, they are therefore limited in their ability to influence management strategy (Berle and Means, 1932; Miller, 1992). Instead, managers supervise the enterprise's routine operations. This arrangement creates a divergence in organizational goals in that shareholders wish to maximize their shareholder revenues while managers generally wish to maximize sales to ensure their job security and promotion (Miller, 1992). In doing so, managers may grow the firm quickly, thus increasing the resources under their control (Miller, 1992). This divergence in organizational goals, however, does not entirely diminish the publicly traded organization's ability to increase profits, as managers enjoy some degree of discretion inasmuch as they are able to achieve a minimum-profit constraint (Alchian and Demsetz, 1972; Baumol, 1976).

Most privately owned operations, in contrast, are small and medium-sized enterprises whose resources largely depend on the private wealth of a single individual or family. These businesses generally have a smaller presence in the market place and fewer resources (Johannson, 1997; Darnall, 2003), and often consider environmental problems outside their area of concern. As such, small and medium-sized organizations are less likely to invest in the basic forms of environmental management that would otherwise facilitate EMS adoption (Johannson, 1997). For example, because of the risk of employee turnover, (Marshall *et al.*, 1995) privately owned companies are less likely to provide professional development opportunities for their human resources (Finegold and Soskice, 1988) to improve the organization's environmental performance. This resistance is rooted in the belief that training internal staff in highly specialized environmental management techniques may encourage them to seek employment opportunities with larger, more branded companies (Johannson, 1997). Faced with fewer resources and greater risk of employee flight, privately owned enterprises more often rely on expertise from external sources (Shaper and Raar, 2000) such as professional environmental consultants. As a result, implementing an EMS in the privately owned business may be more costly. To minimize the financial burden to small- and medium-sized enterprises, the Environmental Protection Agency (EPA) is offering them significant EMS design assistance (Stapleton and Glover, 2001).

Others have suggested that the small and medium-sized organizations have certain advantages over larger publicly traded organizations in implementing an EMS (Stapleton and Glover, 2001). In smaller organizations, most of which are privately owned, lines of communication are generally shorter, organizational structures are less complex, employees often perform multiple functions, processes are generally well understood and access to management is simpler (Stapleton and Glover, 2001). For privately held organizations that have strong internal capabilities, these factors may translate into a less costly EMS design process.

In contrast to both types of for-profit firms, the objective of government operations is to address public welfare. Government enterprises exist to ensure equal access to goods and services that could not be reliably acquired through the private market (Downs and Larkey, 1986). Government entities also are more likely to provide labor-intensive services (Bartlett, 1998). While higher-order environmental management activities are generally people intensive (Hart, 1995), government enterprises are less likely to allocate their labor towards

pollution prevention or other environmental capabilities because they often lack resources to do so. Government organizations also generally have fewer resources than for-profit enterprises (Kettl, 1993). Complicating matters is the fact that since the 1990s voters have become less willing to accept additional tax burdens (Gordon and Milakovich, 1998). These factors reduce government's ability to generate additional resources towards improving its basic environmental management functions. Moreover, because government enterprises often are constrained by statutory rigidity and political constraints from adapting to new missions or even from adopting more efficient means of achieving their assigned missions, many may have less incentive to develop and continually improve their environmental management practices. Absent a competitive environment, moreover, government organizations may have fewer reasons to invest in developing these capabilities (Kettl, 1993).

In general, publicly traded organizations are expected to have the *lowest* EMS design costs, because of their greater access to resources and stronger capabilities that may support the EMS design process. Government facilities, in contrast, are expected to have the *highest* EMS adoption costs, because of their tendency to accrue fewer internal resources and capabilities that support EMS design. Finally, privately owned enterprises are expected to incur EMS design costs somewhere between the other two organizations, because of their likelihood to possess moderate internal capabilities and resources. This discussion leads to the following three hypotheses:

Hypothesis 1: Compared to privately owned and government organizations, publicly traded organizations incur lower EMS design implement costs. Government facilities spend the most.

Hypothesis 2: Organizations with stronger capabilities and greater access to resources have lower EMS design costs

Hypothesis 3: Compared to privately owned and government organizations, publicly traded organizations have greater capabilities and resources prior to EMS adoption. Government facilities have the least.

METHODS AND SAMPLE

The three hypotheses were tested using data from the National Database of Environmental Management Systems (NDEMS). NDEMS contains data for all facilities that participated in a nation-wide EMS Pilot Program sponsored jointly by the Multi-state Working Group (MSWG) and EPA. Approximately 90 U.S.-based facilities in 10 states participated in the program. The program was designed to determine the potential EMSs have for improved environmental performance and for future regulation (Andrews, 2001). Facilities that participated in the program were required to contribute their EMS adoption data to NDEMS.

In return, pilot participants received small grants for EMS design training, public recognition, consultant support, technical assistance and data collection assistance.

Environmental managers at each pilot facility provided survey data to NDEMS. The database contains information for each pilot facilities' baseline operations during the three years prior to adopting an EMS. It also contains data on the processes by which participants designed and implemented their EMSs, as well as post-design performance data.

Two conditions were imposed before a facility was included in this study. First, the facility had to have contributed baseline and EMS design data for the questions of interest. Second, to ensure that each organization had established an EMS by the time of this study, facilities were required to have designed their environmental policy and identified their environmental aspects and impacts. Facilities also had to have established their objectives and targets in order to ensure comparability across facilities' EMS design costs. Forty-two facilities were included in the analysis—20 publicly traded, 16 privately owned and 6 government enterprises. The sample represented 53 percent of the NDEMS facilities and 69 percent of NDEMS facilities that reported both baseline and EMS design data.

The dependent variable, EMS design costs, was measured using facilities' self-reported expenditure data for the following eight EMS cost categories: staff time, consultants, travel and training, equipment, materials, corrective action, auditors and ISO 14001 certification. The cost of implementing an EMS can be highly variable, although it is often proportional to the size and complexity of an organization (Graff, 1997). To address hypothesis 1, costs were normalized by dividing EMS design expenditures by the number of employees who were covered by the facility's EMS. To reduce variability in the dependent variable in hypothesis 2, EMS costs were logged. Finally, to address hypotheses 3, organizational structure was measured by whether the NDEMS facility was a publicly traded, privately owned or government enterprise.

To measure facilities' management system capabilities, NDEMS facilities were asked whether they had implemented Total Quality Management Principles (TQM) prior to EMS design. A second form of management system capability—the ISO 9000 quality management system (QMS)—was also included. Finally, facilities were asked whether they had implemented any other management system, including Just-in-Time inventory management (JIT), materials accounting or another formal system. Each of these variables was coded as a dummy variable.

Facilities' environmental management capabilities were measured by whether they had participated in pollution prevention activities prior to adopting an EMS. Pollution prevention activities were defined as any materials substitution, process changes or other activities that minimized waste production prior to EMS adoption.[97] In addition, two more advanced environmental management capabilities were also included—whether or not facilities incorporated pollution prevention strategies into their future business planning and whether or not facilities employed advanced environmental management techniques (including life cycle analysis, environmental best practices, risk assessment or environmental accounting) prior to EMS adoption.

[97] Pollution prevention does not include activities such as pollution recycling/reuse (other than in-process recycling), waste treatment, and disposal of waste or its release into the environment because in each of these examples waste is first produced and later controlled.

Finally, facilities' slack resources were measured first by whether or not they had a parent organization. Recognizing that design of environmental initiatives in multi-plant organizations often depends on the incentives and the resources available to facilities (Bowen, 2000),[98] a second measure was also incorporated. Facilities with parent companies were asked whether the parent enterprise provided (1) financial support, (2) technical support, (3) an EMS design template or (4) corporate endorsement for EMS design[99].

Two external resource variables were included: a dummy indicating whether or not facilities relied on external consultants during EMS design and an ordinal variable (high, medium or low) indicating whether or not state-sponsored technical assistance influenced their EMS adoption decision.[100]

Finally, two control variables were included. The first was the number of employees within each organization that were covered by the EMS during 2000 and the other was a dummy that measured whether or not the facility was certified to or seeking ISO 14001 certification.

Responses were grouped by costs, capabilities and resources described above for each of the three types of facilities. Three statistical tests were performed. The Wilcoxon-Mann-Whitney (WMW) test was used to evaluate whether EMS design costs for the three types of facilities differed (hypothesis 1). In interpreting the results of this test, the continuous variable, (cost per employee), is the dependent variable and organizational type (which is categorical) is the independent variable.

Linear regression was used to determine whether the independent variables predicted facilities' EMS cost (hypothesis 2). To correct for heteroskedasticity, dependent variable (cost) was estimated using generalized least squares regression. Robust standard errors were used, as was clustering by organizational type to take advantage of the fact that the observations were independent across ownership types.[101] By summing over the clusters, correlations between facilities within the same cluster were measured. While clustering affects the variable estimates, in general the bias is downward (Hardin and Hilbe, 2001) suggesting that if a statistically significant relationship is found it may be larger than the coefficients suggest.

[98] While a more precise measure of organizational slack would have incorporated specific information about discretionary slack (Sharma, 2000), NDEMS does not contain such information.

[99] All three types of facilities were asked whether or not they were part of a larger business or government organization, and whether their facility or its parent organization was publicly traded, privately owned, a municipality, or a federal facility. For government facilities, this relationship typically involved a facility that was part of a larger municipal government or federal agency. Parent company support was not considered to include capabilities and resources provided by the pilot programs themselves, since these were provided by other federal or state agencies (U.S. EPA, state environmental agencies) rather than by the government organizations of which the facilities were subsidiaries.

[100] The NDEMS ordinal scale also includes a "not applicable" category. Because of the ambiguousness between the "low" and "not applicable" classification, these two responses were collapsed into the "low" category.

[101] Clustering was justified by the results of the Fisher's exact tests (hypothesis 1).

The following empirical model was tested, where i represents each pilot facility:

$$\text{Log(total cost)} = \Sigma\beta_1(\text{management system capabilities})_i + \Sigma\beta_2(\text{environmental management capabilities})_i + \Sigma\beta_3(\text{access to resources})_i + \beta_5(\text{employees}) + \beta_4(\text{ISO 14001 certification})$$

Finally, the WMW and Fisher's exact test were used to determine whether internal capabilities and access to resources differed by organizational type (hypothesis 3). Both statistical techniques are nonparametric tests of association and are appropriate for small sample (Stokes, Davis and Koch 1995; Hess and Orphanides 1995). Both tests are also resistant to skewed distributions that are often problematic in small samples.[102] In adjusting for sample size, the WMW and Fisher's exact tests estimate highly conservative *p*-values, which is why in addition to the conventional levels of significance ($p \leq 0.01$ to 0.05) more liberal levels ($p \leq 0.10$) are also reported (Kahn and Goldenberg, 1991; Grusky, 1959; Hirota *et al.*, 1999; Rice, 1988; Beirle and Konisky, 2000). One-tailed tests are reported for 2x2 comparisons, since each of the hypotheses specify direction, and two-tailed test results are reported for 2x3 comparisons.[103]

RESULTS

Most (85 percent) of the publicly traded and privately owned enterprises operated in heavy manufacturing industries (i.e. SIC 2000-3999), such as metal finishing and chemical production (see Table XI-1). Ten percent operated in electric, gas and sanitary services (SIC 4900) and 5 percent were wholesalers (SIC 5000). Of the government facilities included in the study, almost all (83 percent) were operational units in local or state governments.

A significant portion of publicly traded facilities (86 percent) belonged to an organization operating internationally. In contrast, only 38 percent of privately owned and no government operations produce goods outside the United States.

All of the privately owned facilities' and most (95 percent) of the publicly traded facilities' EMSs covered the entire plant. Fewer than half (33 percent) of the government facilities' EMS's extended to all facility operations. Across all organizations, EMSs covered between 25 and 4,500 employees. Publicly traded facilities' EMSs covered approximately two and a half times more employees (736) than were covered by privately owned (320) or government (258) operations.

[102] The WMW test and the Fisher's exact test are similar to an analysis of variance test (ANOVA) and Chi-square test, respectively, and in larger samples yield statistically equivalent results. A rule of thumb for using the Chi-square test is that there exist at least five counts (and preferably greater than 10) in each cell of the contingency table (Stokes, Davis, and Koch, 1995). Since most of the tables used in this analysis are 2x2 or 3x2, the Chi-square count requirement could not be met.

[103] One-tailed Fisher's exact tests cannot be calculated for 2x3 contingency tables.

TABLE XI-1: SUMMARY OF FACILITY CHARACTERISTICS BY OWNERSHIP TYPE

Characteristic	*Publicly Traded (n=20)*	*Privately Owned (n=16)*	*Government (n=6)*
Industry Type	Manufacturing—85% Electric, Gas, Sanitary—10% Wholesale Distribution —5%	Manufacturing—94% Electric, Gas, Sanitary—6%	National—17% State/Local—83%
International Locations	86%	38%	0%
EMS Covers Entire Facility	95%	100%	33%
Seeking ISO 14001 Certification	63%	88%	50%
Avg. Number of Employees	781	320	258

OVERALL COST OF EMS DESIGN

In testing whether the EMS design costs per employee differed statistically between the three types of organizations, the results offer support for hypothesis 1 (see Table XI-2). Compared to privately owned and government organizations, publicly traded organizations incurred lower overall costs when designing and implementing their EMS (p=0.04), while government facilities spent the most (p=0.03). Publicly traded facilities spent approximately $267 per employee, in contrast to the $531 and $1,441 that privately owned facilities and government entities spent, respectively. A joint statistical test of these expenditures (p=0.08) offers additional evidence that EMS design costs per employee differ by facility type.

Labor was the most costly component of designing an EMS for all types of NDEMS facilities, accounting for more than half of the average total costs. Labor costs for government facilities were 2.6 times more than privately owned companies' costs, and 4.1 times more than publicly traded facilities' costs. Interestingly the percent of spending allocated towards labor for government facilities was similar to private companies in that both spent over half of their average total costs on staff time.[104]

[104] GETF (2000) also reports that government facilities spend over half of all EMS design expenditures on labor costs.

TABLE XI-2: COSTS OF EMS DESIGN PER EMPLOYEE BY OWNERSHIP TYPE

Cost Category	*Publicly Traded (n=20)*			*Privately Owned (n=16)*			*Government (n=6)*		
	Mean	*S.D.*	*Percent*	*Mean*	*S.D.*	*Percent*	*Mean*	*S.D.*	*Percent*
Labor	$206	219.5	77.2%	$317	371.6	59.7%	$822	1041.6	59.8%
Consultants	$ 12	19.9	4.5%	$ 37	60.6	7.0%	$499	775.6	36.3%
Travel/Training[105]	$ 14	32.2	5.2%	$ 34	99.8	6.4%	$ 50	111.8	3.6%
Equipment	$ 0	1.7	0.0%	$ 33	88.9	6.2%	$ 0	0.0	0.0%
Materials	$ 7	14.6	2.6%	$ 22	46.6	4.1%	$ 1	1.5	0.1%
Auditors, ISO 14001 Registration[106]	$ 28	51.0	10.5%	$ 88	125.6	16.6%	$ 0	0.0	0.0%
AVERAGE TOTAL COST /EMPLOYEE	$267*		100%	$531*		100%	$1441[107]*		100%

* Results of Wilcoxon-Mann-Whitney test show that costs are less for publicly traded facilities than for other facilities (p=0.04). For-profit (publicly traded and privately owned) costs are less than government costs (p= 0.03). In comparing all three facility types EMS design costs per employee also differ (p=0.08).

These organizations differ, however, in the amount spent on consultants in that the government facilities relied on consultants to a much greater degree (p=0.04), having invested approximately $499 per employee (36 percent of EMS design cost) as compared to the $37 per employee (7 percent) invested by privately owned enterprises. Publicly traded facilities relied even less on consultants, having invested only $11 per employee (4.3 percent) for their expertise. Instead publicly traded facilities relied on in-house labor, which accounted for 77.2 percent of their EMS design costs.

NDEMS facilities reported that the majority of their travel/training costs were related to employees receiving EMS auditor training in order to perform in-house assessments of their system. Equipment and materials accounted for 10.3 percent of privately owned facilities' EMS design expenditures, whereas publicly traded and government facilities invested less in equipment and materials (2.7 percent and 0.1 percent, respectively).

Finally, the proportion of facilities seeking certification was similar between publicly traded and privately owned enterprises, as were their costs of ISO 14001 registration. Half of the government facilities were seeking certification of their EMS. None of the government facilities reported any auditing or certification costs, however, because they had yet to complete the certification process.[108]

[105] These costs were reported by facilities under the heading of "Other Costs".

[106] Auditors and ISO 14001 certification costs were combined because these costs are often closely related.

[107] Individual row items do not sum to the column total because one facility was able only to provide total cost of EMS Design. Individual costs by category were not reported by this facility.

[108] Because government facilities have yet to complete the certification process, the results stated here are conservative. That is, the total costs of EMS design for government employees are expected to exceed $1,441 per employee and thus create greater differences between the three facility types.

Predicting EMS Design Cost

Do organizations with higher capabilities and greater access to resources have lower EMS design costs? The results of the regression model, shown in Table XI-3, suggest that they do. After controlling for organization-type effects, the estimates show that facilities' prior management system experience, environmental management experience and access to resources predicted about 60 percent of the variance in the cost of designing and implementing an EMS (R-square=0.5986).

All other variables held constant, facilities with prior TQM experience and experience with other management systems (either just-in-time, materials accounting or another formal management system) incurred fewer EMS design costs than facilities that did not employ these systems (p=0.01). Similarly, facilities that incorporated pollution prevention into their business planning incurred fewer EMS design costs (p=0.01). These results support the resource-based view of the firm that suggests that basic managerial and environmental capabilities act as a foundation for developing more advanced management capabilities. Facilities having these basic capabilities prior to EMS adoption were thus able to reduce their costs of EMS design.

As expected, EMS design costs were greater for facilities that required consultant support and had more employees covered by their EMS. In addition, facilities that relied on government assistance mitigated their EMS design costs. These findings also indicate that facilities with stronger internal capabilities and greater access to environmental resources prior to EMS adoption minimized their costs of designing and implementing an EMS in part because they did not require the external assistance.

TABLE XI-3: REGRESSION RESULTS TESTING THE EFFECTS OF FACILITY CAPABILITIES AND ACCESS TO RESOURCES ON EMS DESIGN COSTS

Independent Variable	Coefficient	Robust S.E.	Z
TQM principles	-0.556	.108	-5.17***
ISO 9000 certification	0.289	.326	0.89
Other management system experience	-0.774	.228	-3.40***
Pollution prevention activities	-0.236	.303	-0.78
Pollution prevention plan	0.255	.194	1.32
Pollution prevention in business planning	-0.675	.176	-3.83***
Existence of parent company	0.650	.317	2.05**
Required consultant support	1.003	.141	7.12***
Govt. assistance	-0.533	.105	-4.91***
Number of employees covered by the EMS	0.001	.000	5.04***
ISO 14001 certification	-0.257	.175	-1.47
Constant	10.410	.170	61.17***
Observations	42		
R-square	0.5986		

The regression was estimated using GLS. Robust standard errors with heteroskedasticity correction and clustering by facility type were used to allow for within facility-type correlations. Dependent variable: Log of total facility expenditures for the design their EMS. *** p =0.01, ** p =0.05, * p =0.10

Interestingly, ISO 9000 certification had no statistical effect in predicting the cost of EMS design. This finding may be due to the fact that many NDEMS facilities had adopted TQM prior to certifying to ISO 9000. As a result, these organizations may have developed their management system capabilities prior to ISO 9000 certification and thus had already claimed the low hanging fruit from increasing product quality. However, additional data are needed to test these relationships.

Facilities that either had certified to or were seeking certification to ISO 14001 did not incur greater adoption costs than facilities that were not certified. This result is interesting because facility managers often believe that ISO 14001 certification significantly increases EMS design costs. Indeed, other factors appear to play a more important role.

Finally, larger facilities incurred greater EMS design costs, as did facilities with parent companies.[109] The fact that facility size contributes to EMS design costs was expected since EMSs for larger enterprises generally require additional resources. The latter finding, however, was not anticipated, and may be due to the fact that parent companies, while often providing resources to their operational units, may also impose additional requirements in their facilities' EMSs that would otherwise not be considered. Parent companies, for example, often require significant coordination with sister facilities, other divisions and subsidiaries, all of which potentially increase EMS design costs.

Differences in EMS Design Costs by Organizational Structure

While the regression results support the view that organizational capabilities and resources predict EMS design costs, these resources are likely to vary for different types of organizations. The following results provide evidence for this argument (hypothesis 3).

Table XI-4 shows that while publicly traded and privately owned facilities adopted TQM at similar rates (48 percent and 31 percent, respectively), they differed from government facilities (p=0.06). Indeed, none of the government facilities had implemented TQM principles prior to EMS adoption. Similarly, publicly traded and privately owned facilities certified to ISO 9000 at similar rates, while none of the government facilities were certified to the standard (p=0.01).

Similarly, over three-quarters of publicly traded organizations utilized other management systems (either Just-in-Time, materials accounting or another formal management system) prior to EMS adoption. By contrast, half of the privately owned firms (p=0.10) and none of the government facilities had such systems in place (p=0.01). These findings suggest that government facilities had lower management system capabilities than both publicly traded and privately owned facilities. They also imply that publicly traded facilities had more robust management system capabilities than the other facility types.

All three types of facilities engaged in pollution prevention activities at similar rates prior to EMS adoption. Between 67 and 88 percent of the facilities reported using pollution prevention in their internal operations at some point during the three-years prior to EMS adoption. These proportions change, however, when considering more rigorous pollution prevention techniques. None of the government facilities, for example, reported that they considered

[109] Although one might speculate that these two variables measure the same concept, there is only a 34 percent correlation between them.

pollution prevention in their management planning, while nearly half of the publicly traded and privately owned companies did (p=0.04).

TABLE XI-4: PERCENT OF FACILITIES HAVING VARIOUS CAPABILITIES AND ACCESS TO RESOURCES AND STATISTICAL DIFFERENCES BETWEEN FACILITY TYPES

Variable	Facility Characteristic			Statistical Differences between:		
	Publicly Traded (n=20)	*Privately Owned (n=16)*	*Govern-ment (n=6)*	*All Three Types of Facilities*	*Publicly Traded/ Privately Owned*	*For-Profit/ Govt.*
MANAGEMENT SYSTEM CAPABILITY						
TQM practices	48%	31%	0%	--	--	0.06
ISO 9000	71%	63%	0%	0.01	--	0.01
Other management system experience	76%	50%	0%	0.01	0.1	0.01
ENVIRONMENTAL MANAGEMENT CAPABILITY						
Pollution prevention activities	86%	88%	67%	--	--	--
Pollution prevention in business planning	48%	44%	0%	--	--	0.04
Advanced environmental management techniques	81%	25%	17%	0.01	0.01	0.08
ACCESS TO INTERNAL RESOURCES						
Existence of parent company	90%	69%	83%	--	--	--
- Parent provides financial support	29%	20%	100%	--	--	0.09
- Parent provides technical assistance	68%	27%	20%	0.04	0.03	--
- Parent provides EMS template	68%	18%	0%	0.01	0.01	0.05
- Parent encourages or req. EMS	84%	64%	20%	0.03	--	0.03
Utilized consultant services	33%	69%	50%	0.10	0.03	--
- Dollars spent on consultants*	$12	$37	$499	0.04	--	0.02
Government assistance was important motivator	10%	44%	83%	0.01	0.01	0.01
CONTROLS						
ISO 14001 certification	63%	88%	50%	--	--	--
Number of employees**	736	320	258	--	0.07	0.09

* Represents a continuous variable and is a value per employee.
** Represents a continuous variable and is a mean value.

Similarly, 81 percent of publicly traded organizations reported using either life cycle analysis, environmental best practices, risk assessment or environmental accounting prior to EMS adoption, while only one-quarter of privately owned enterprises had experience with these advanced environmental techniques (p=0.01). Even fewer government facilities (17 percent) reported using such techniques.

As expected, publicly traded facilities employed more workers than either privately held (p=0.07) or government (p=0.06) facilities. Despite their larger size, however, the publicly traded organizations were no more likely to have parent companies than privately owned or

government facilities. Publicly traded facilities were also no more likely to have certified to ISO 14001.

Interestingly, there were striking differences in the support that parent companies provided for facility-level EMS development. Government facilities received greater direct financial support from their parent organizations than the other facility types (p=0.09). All of the NDEMS government facilities received monetary assistance from their parent organizations, as compared to 29 percent of publicly traded and 20 percent of privately owned facilities. Yet, in spite of their increased monetary support, government facilities' EMS design costs were still greater (p=0.03).

In general, publicly traded facilities received more in-kind technical assistance from their parent companies (p=0.04). Over two-thirds of publicly traded facilities received technical assistance (68 percent), whereas less than one-third of parent organizations of privately owned (27 percent) and government (20 percent) enterprises provided technical support. Other support came in the form of a pre-designed EMS template that parent companies provided their facilities to facilitate the EMS design process. Such templates were supplied to 68 percent of publicly traded organizations. By contrast, none of the government facilities and 18 percent of privately owned facilities (p=0.05) received EMS templates.

The dearth of in-kind support that parent enterprises offered their government facilities, coupled with their lower overall capabilities, may explain why government facilities relied on consultant services to a greater extent than either publicly traded or privately owned facilities. Government facilities spent 12 times more per employee than privately owned facilities and 38 times more than publicly traded facilities on consultants (p=0.02), as was shown in Table 3. Interestingly, privately held facilities spent no more on consultant services than publicly traded facilities.[110]

Similar differences are seen in the influence of government support on facilities' decisions to adopt an EMS. Eighty-three percent of government facilities reported that government support was a "high" or "moderate" influence on their EMS adoption decision, whereas 44 percent of privately held facilities reported the same level of influence (p=0.01). In contrast, none of publicly traded facilities reported government assistance as a high influence on their adoption decision, and only 10 percent reported it to be a moderate influence.

In sum, the results offer support for all three hypotheses. An organization's internal capabilities and access to resources predicted EMS design costs. These costs are greater for government enterprises and lesser for publicly traded facilities most likely because publicly traded organizations had greater capabilities and resources prior to EMS adoption while government entities had the least.

[110] As was previously noted, a variety of incentives – including state-sponsored monetary grants – were offered to facilities participating in the NDEMS study. Several of the NDEMS facilities that were privately owned reported that they relied on consultants during EMS design. They did not, however, report any costs associated with these services. Instead, these facilities noted that consultant fees were offset by the state grants. As a result, consultant expenditures are understated.

CONCLUSION

This study begins to understand the factors that predict EMS design cost, and how these costs might vary for different types of organizations. The findings suggest that a facility's internal capabilities and access to resources predict its EMS adoption cost. Facilities with stronger internal capabilities prior to EMS adoption incurred *lower* EMS design costs, whereas facilities with fewer organizational capabilities incurred *higher* design costs. Of the three types of facilities considered, publicly traded facilities incurred lowest EMS design costs. They also had the strongest internal competencies prior to EMS adoption. In contrast, government facilities had the weakest competencies as well as the most costly EMS design process. Privately owned facilities fell in between the two extremes with moderate internal capabilities and EMS design costs.

EMSs are predicated on internal evaluation, employee involvement, monitoring, knowledge development and improvement of operational factors. They are based on a highly systematic framework that at a basic level focuses on pollution prevention as an environmental strategy. Such strategies depend upon tacit skill development through employee involvement (Cole, 1991; Lawler, 1986; Hart, 1995) and work in teams (Makower, 1993, Willig, 1994; Hart, 1995). The decentralized and tacit nature of this capability makes it difficult to replicate quickly (Hart, 1995).

At a more advanced level, EMSs have the potential to move organizations towards product stewardship and adopting life-cycle cost analysis tools, taking a proactive stance toward raw material and component suppliers, and develop close working relationships with staff to elevate environmental concerns throughout the organization (Shrivastava, 1995a; Hart, 1995). If organizations consider jointly all of the aspects of their operational systems, this awareness helps them to prevent the shifting of environmental harm from one subsystem to another (Shrivastava, 1995b). EMSs thus meet RBV criteria of a tacit internal competency that may lead to competitive advantage.

The results of this research indicate that facilities with lower EMS adoption costs were more likely to have well-developed quality management systems. Such findings support Hart's (1995) proposition that organizations with demonstrated quality management systems have fewer barriers implementing advanced pollution prevention strategies (Hart, 1995) such as EMSs. Because of their prior competency, these facilities have more quickly assembled the resources for advanced pollution prevention than enterprises lacking these prior capabilities. Quality management strategies require the voluntary involvement of large numbers of people, especially line employees, in continuous-improvement efforts (Imai, 1986; Ishikawa and Lu, 1985) and thus provide a foundation for EMS design. These competencies also reduce the costs of EMS adoption.

In addition, the ability to adopt an EMS with fewer costs appears to be dependent upon first demonstrating competence in pollution prevention or other more advanced environmental management techniques. These findings also support prior RBV literature suggesting that early accumulation of resources in pollution prevention provides a foundation (Hart, 1995; Hart and Ahuja, 1996) upon which EMSs can be assembled more quickly. This study therefore offers additional evidence for prior RBV research suggesting that basic level capabilities are embedded in more advanced environmental strategies and contributes to a growing literature (see Christmann, 2000; Hart, 1995; Sharma and Vredenburg, 1998) on the

topic. It extends prior research by showing that organizations that are able to leverage their prior investments in environmental management may be able to reduce the costs of implementing more advanced environmental strategies, such as EMS design.

Interestingly, facilities lacking strong internal capabilities were able to rely on external support from government-sponsored technical assistance and environmental consultants, making EMS adoption possible. Government support also mitigated their EMS adoption costs. It is unclear whether the external support (of any kind) also expanded facilities' internal capacities, thus making their EMS sustainable over time.

Future research should consider whether organizations that rely on external environmental expertise are able to maintain their EMSs to the same extent as facilities that relied on their stronger internal competencies. Some organizations may in fact be able to push their newly learned capabilities deep into what Jennings and Zandergen (1995) describe as the enterprises' learning systems, creating congruence across the strategic, structural and learning systems. Doing so may help ensure environmental sustainability (Jennings and Zandergen, 1995). For other organizations, however, such accomplishments may be a challenge. Some facilities may choose either to abandon their EMS in the long run, settle for less ambitious environmental goals or acquire additional external support to continually improve it over time.

Finally, future research should consider how facilities' prior capabilities affect the robustness of their EMS and how environmental performance changes over time. This study suggests that enterprises with stronger continuous improvement capabilities and environmental management proficiencies will leverage their expertise more efficiently to continually improve their systems providing greater opportunities for competitive advantage. It also suggests that publicly traded organizations may be more successful at designing a robust EMS and maintaining it over time. Such improvements are necessary in order to generate a stream of innovations and achieve competitive advantage (Sharma and Vredenburg, 1998). Time will tell whether this continual environmental improvement is possible and whether such improvements vary for different types of organizations.

Chapter 12. Benefits of EMS Adoption

INTRODUCTION

Other than improved environmental performance and compliance, what benefits do facilities believe that they gain from EMS adoption? This chapter analyses both unquantified and quantified benefits, if any, which NDEMS facilities attributed to introduction of the EMS.

DATA AND METHODOLOGY

Within the context of this study, benefits reported during the EMS Design process refer to the initial period of EMS design, including the formalization of an environmental policy statement, determination of the scope of the EMS, first-round assessment of the facility's activities, aspects, and impacts, significance determination, selection and approval of initial objectives and targets, and potentially some initial fraction of the associated implementation actions (such as assignment of responsibilities, training, and initial actions to achieve objectives and targets). As a practical matter, the EMS Design protocol captured responses approximately one year after the Baseline Data period, and the First and Second Update Protocols captured responses approximately one and two years (respectively) after the EMS Design Protocol. For most facilities the update periods focused on implementation of the initial EMS objectives and targets, although some were still elements of the EMS design process.

Many facilities were unable to identify a specific point at which EMS design ended and "implementation" began, inasmuch as some considered their EMSs to be constantly evolving and thus never completely "implemented." All of these facilities had completed at least one management review of their initial objectives and targets, though many were at various stages of "implementation."[111]

Data for these analyses were provided by the 37 facilities that completed the first update protocol. The data cover a total period of 2.5 years, on average, after the baseline data were reported. These facilities provided data on what benefits, if any, were accrued at the site from both design and implementation of the facility's EMS. Non-monetary benefits were examined for common trends among reporting facilities, and common responses were grouped into broad categories in order to develop a benefits template for further investigation. Facilities were asked to report both monetary and non-monetary benefits. Monetary benefits that were observed during either the design or update period were totaled, and the costs reported were

[111] For example, some facilities were in the process of training employees during the update period while others were developing new objectives and targets lists after initial management review and others were in the process of pursuing objectives and targets from the first cycle.

subtracted from these data to estimate net monetary benefits from design and implementation.[112]

PERCEIVED BENEFITS

A large majority of the NDEMS facilities (86 percent) reported benefits from the design and implementation of their EMS. Many of these perceived benefits, however, were not or could not be quantified (Table XII-1). Together, these facilities described a number of benefits that were divided into six broad categories – increased management efficiency, increased operational efficiency, reduced liability, regulatory benefits, improved community relations and improved customer/supplier relationships.

TABLE XII-1: BENEFITS OF EMS DESIGN AND IMPLEMENTATION

Benefit Category	Percentage of NDEMS Facilities with Observed Benefits		
	DESIGN COLLECTION PERIOD n=30	UPDATE COLLECTION PERIOD n=29	DESIGN or UPDATE n=32
Increased Management Efficiency	93%	79%	94%
Increased Operational Efficiency	47%	72%	78%
Reduced Liability	23%	52%	53%
Regulatory Benefits	27%	48%	53%
Improved Customer/Supplier Relations	10%	14%	19%
Community Relations Improvement	3%	13%	13%

The benefits reported by three NDEMS facilities provide illustrations of the principal types of benefits reported.

One facility reported benefits associated with a change in an environmental performance indicator that was attributed to the facility's EMS. This facility realized a reduction in the amount of industrial trash hauled to the landfill by communicating cardboard recycling procedures to employees throughout the facility and through the purchase of a cardboard baler to collect these recycled materials. Not only did the facility realize a benefit from the reduction in hauling costs, they also reported a reduction in associated environmental liability. Though this facility did not quantify the costs or benefits resulting from this change, they did report that the savings from reduced hauls to the landfill exceeded the costs of equipment purchased and the facility-wide recycling efforts.

A second facility reported several significant changes in environmental performance due to the implementation of their EMS. This facility decreased the amount of wastewater produced, decreased the amount of copper released to the POTW, and decreased the amount of sludge produced through the purchase of monitoring equipment. In addition, the facility reduced the use of one chemical by testing a less hazardous product in their production process. The

[112] See Chapter 11 for a more detailed discussion of NDEMS facilities' EMS design expenditures.

facility found the use of this product to be effective and intended to move toward eliminating the use of the more hazardous chemical. The facility decreased the reject and waste ratios of their product and realized savings from the treatment of one acid by increasing the usage of another. Finally, the facility reduced air emissions associated with one of its treatment procedures through more frequent monitoring and thus more timely corrective action.

While this particular facility was able to quantify a number of reported benefits, its ability to assign monetary values for other benefits was more limited. For example, the facility reported that decreased water usage and elimination of copper discharge violations associated with increased monitoring of wastewater could not be quantified, however they were able to report approximate savings totaling $2,500 as a result of decreased emission fees resulting from reductions in the use of the chemical, and reported additional savings of $8,500 in the use of filters as a result of more frequent monitoring and timely corrective actions to the treatment procedure. Overall, the facility listed benefits such as reduced water usage, material costs, waste generation and disposal. They also reported reduced costs associated with air emissions fees and air quality monitoring, as well as increasing compliance adherence and employee involvement and morale. These actions also resulted in reduced workers' compensation claims and health and safety liability. The facility's quantified benefits totaled approximately $317,000, of which more than one-third was attributed to reductions in the amount of waste generated due to rejects. The remaining two-thirds of these monetary benefits were attributed primarily to the reduced costs of wastewater treatment (i.e., chemical purchases) and reductions in materials costs such as filters.

A third facility reported few changes in environmental performance, but derived many benefits from these changes. This facility reduced VOC emissions and hazardous waste disposal through a review of its production practices. The facility experienced improvements in staff response time, reduced material and disposal costs, reduced permit fees, and reduced energy use by eliminating certain production processes and hazardous product use. Though the facility could not quantify these benefits, it did report that these actions allowed it to maintain its status as a small-quantity hazardous waste generator and that few costs were involved once changes were implemented.

The benefits reported by the first and third facilities, described above, appear to be common rather than exceptional results for facilities reporting in NDEMS. Thirty-two facilities reported benefits during the design and implementation of the EMS, but 76 percent of them were unable to quantify these benefits or unwilling to commit the effort to do so. Patterns in the reported benefits suggest that in general, the EMS led to increases in the operational efficiency of the facility which were reported as reductions in inputs such as energy, water and materials or reductions in waste generation and disposal. More than three-quarters of the facilities for which benefits were observed (25 facilities) identified benefits of this nature. Operational benefits were observed nearly as frequently during the EMS design data collection phase (61 percent) as during the update data collection phase (71 percent).

Improvements in management efficiency – described by these facilities as increased employee involvement, and illustrated by the report of the second facility above – also were commonly observed. These benefits from management efficiency – reported by these facilities as improved planning and continual improvement, documentation, management commitment and use of employee staff time – also were commonly observed both during EMS design (93 percent) and during the update periods (79 percent). These benefits appeared to be more

difficult to quantify, however, than benefits experienced due to operational efficiency. For example, even though a large proportion of facilities reported benefits from increased management efficiency during the design phase, none were able to quantify this benefit. Similarly, only one facility (the second facility above) was able to quantify any of its reported management efficiency benefits. This facility reported $1,600 saved due to decreased employee handling of sludge. The experience of this facility illustrates the importance of such management benefits, as it shows that even though such benefits often are difficult to quantify, they can affect the bottom line in a tangible sense.

Reductions in liability were observed as benefits to EMS design in more than half of these facility reports (53 percent). Benefits from reductions in insurance costs, long-term environmental liability, and health and safety liability also were reported during both the update and design phases by some facilities. For example, NDEMS facilities reported that reductions in environmental liabilities were obtained from less frequent use of landfill facilities, reductions in waste generation and fewer toxic emissions. Reductions in health and safety liability were attributed to fewer employee contacts with toxic substances as a result of the elimination of processes and/or chemical substitutions. One facility reported saving $1,000 in facility insurance premiums during the update period that were attributed to the EMS. Other facilities were unable to quantify these benefits. Benefits in this category were observed at more NDEMS facilities during the update period (52 percent) than during EMS design (23 percent).

Benefits related to improved relationships with regulators also were reported by a majority of the NDEMS facilities (53 percent). These facilities described improved compliance, improved regulator relationships, reduced violation fines and expedited permits as benefits of EMS design and update. As illustrated by the examples of the second and third facilities, above, and consistent with our findings in Chapter 10, reduced violations were indeed observed at these facilities. Few were able to quantify these benefits, however.

Though the experiences of the facilities highlighted above capture many of the benefits reported by NDEMS facilities, and provide context for the manner in which these benefits were observed, they are not comprehensive. Benefits also were reported associated with improved community relations (3 percent during design, 13 percent during update) and improved supplier and customer relations (10 percent during design, 14 percent during update). These benefits were not quantified and were reported as maintenance of the current customer base and improved communication with suppliers.

QUANTIFIED BENEFITS

Eighty-six percent of the 37 NDEMS facilities that provided update data also reported information on the benefits of EMS design. Total monetary benefits reported by NDEMS facilities that provided update data are presented in Table XII-2.

TABLE XII-2: QUANTIFIED BENEFITS OF EMS

(Averages, by Type and Reporting Period)

Data Collection Period	Average EMS Development and Implementation Benefits								
	Total	Staff	Mater-ials	Insur-ance	Waste	Fines	Water	Un-specified	Revenue Gained
	n=32	n=32	n=32	n=32	n=1			n=1	
Design	$10,906	$0	$0	$0	$175,000	--	--	$174,000	--
	n=32	n=32	n=32	n=32	n=8	n=2	n=2	n=2	n=1
Update	$79,413	$357	$45,077	$31	$91,391	$111,250	$16,361	$50,000	$40,250
	n=32								
Total	$90,320								

Monetary savings during the design period were infrequently observed, although two facilities (6 percent) reported approximately $350,000 in total savings during their design phase; half of this total was reported by one facility as savings in waste disposal costs, while the remaining savings were unspecified. During the update period, monetary savings were reported by a greater number of facilities, but three quarters of the facilities (76 percent) did not identify any monetary savings during this period. The average savings observed was $79,493. Of those facilities reporting savings during the update, the highest was approximately $1,217,000, while the lowest was $24,000. One facility reported increased revenue attributed to implementation of its EMS totaling $40,250. Of the quantifiable monetary benefits reported, average savings per facility from reduced materials use totaled approximately $45,077, which accounted for 57 percent of the average total benefits.

The experience of one facility provides a number of examples of the savings and revenue benefits that were quantified by the NDEMS pilots. For instance, this facility reported approximately $273,000 in savings from the reduced use of materials at the site by using more efficient chemical processes in the production of their primary product and by modifying the packaging of the final product. Monetary benefits reported in the "other" category, which averaged approximately $34,000 per facility, accounted for an additional 43 percent of the average total benefits.

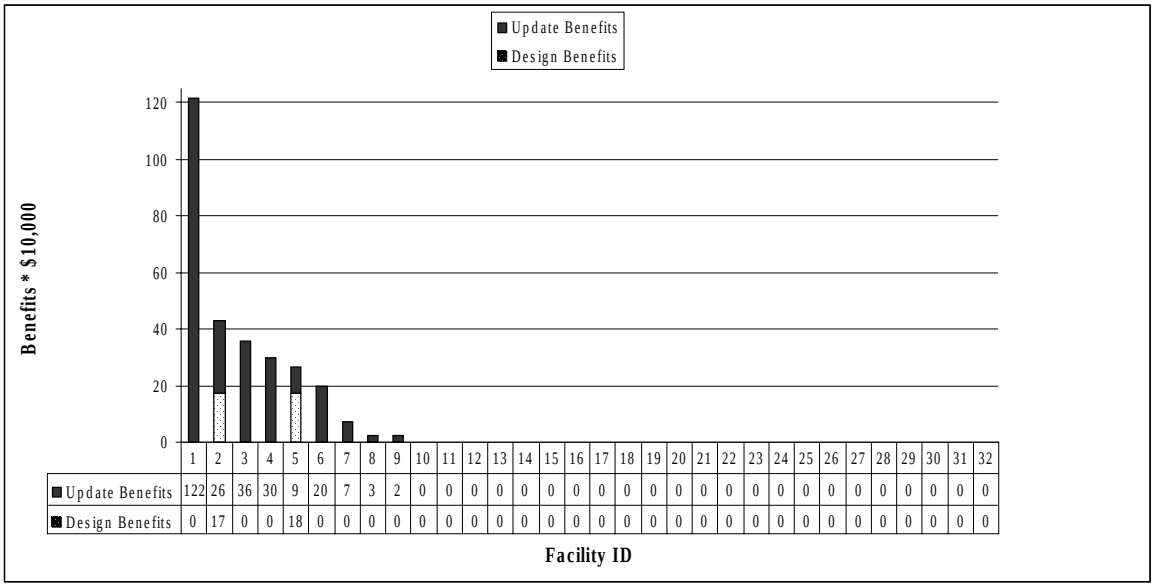
Of the savings that were characterized as "other," three common categories emerged: reduced waste disposal costs, reduced fines, and reduced water costs. Eight of the nine facilities that identified savings during the update period reported an average of $91,391 in savings related to decreased waste disposal expenditures. One facility reported that it was able to save almost $10,000 per year by altering the amount of soap used to clean their floors; changes in production scheduling, which reduced grease waste, amounted to an additional $350 annual savings in waste disposal costs. At this same facility, a large proportion of site employees spoke English as a second language; by changing their method of communicating recycling procedures to employees, savings of $12,000 per year were realized from reduced waste-disposal costs.

Benefits in the form of savings from reduced water costs and avoided fines also were reported, though much less frequently. One facility estimated that $220,000 in fines was avoided by increased monitoring of regulated activities. Yet another reported that more frequent monitoring of water use during the facility's production processes contributed approximately

$30,000 per year in savings. Savings in these categories, again, were less frequently observed (two facilities, respectively, for fine avoidance and water costs), as were savings in increased staff efficiency averaging approximately $400 (three facilities) and insurance costs totaling $1,000 (one facility).

As previously noted, only one facility quantified increased revenues as a result of their EMS. In this single instance the facility reported generating more than $40,000 in additional revenue due to their ability to reduce VOC emissions below permitted amounts and to sell these excess ATU (Air Toxics Units) on an emissions permit market.

While the average savings of the observed benefits at these facilities – $90,320 for both design and update periods – appeared somewhat impressive, it is important to reiterate that this result was largely driven by the success of a relatively small number of the pilot facilities. Most facilities were unable or unwilling to report quantitative monetary benefits of their EMS. The total benefits per facility are presented in Figure XII-1.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Update Benefits	122	26	36	30	9	20	7	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Design Benefits	0	17	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure XII-1: Total Facility Benefits

On the whole, net monetary benefits were negative over the combined design and implementation periods.[113] The average observed cost for design was approximately $92,000. The highest reported design cost was $273,000, the lowest was $3,000.[114] Net monetary benefits during the EMS design period averaged approximately ($81,000).

While the majority of NDEMS facilities (59 percent) reported no additional monetary costs during the update period, the average cost observed across all facilities was approximately

[113] The net benefit was determined for each facility by subtracting reported monetary costs from total reported monetary benefits. In cases where reported costs exceeded total monetary benefits, these numbers are described as negative benefits. These results were then averaged to determine the net benefit (positive or negative) for those reporting facilities. Negative net benefits are costs, and within this text and Table XII-1 are noted within parenthesis e.g., ($xx,xxx).

[114] These results are statistically equal to the larger NDEMS sample discussed in Chapter 11.

$24,500. The majority of these costs were attributed to the acquisition or upgrading of equipment (62 percent). Average staff and materials costs during the update period each accounted for approximately 10 percent of total average costs. Average costs for consultants, auditors and registration during the update period accounted for an additional 14 percent. No costs were reported for corrective action during the update, while 4 percent of the average total costs during this period were attributed to increased waste disposal expenditures.[115] Net monetary benefits during the update period averaged approximately $55,000. Interestingly, benefits outpaced costs for seven of the eight facilities reporting monetary benefits during the update period (Table XII-3).

TABLE XII-3: NET MONETARY EMS DEVELOPMENT AND IMPLEMENTATION BENEFITS

	TOTAL		DESIGN COLLECTION PERIOD		UPDATE COLLECTION PERIOD	
	Mean	Median	Mean	Median	Mean	Median
n=32						
Costs	($116,492)	($78,500)	($92,002)	($64,000)	($24,461)	($0)
Benefits	$90,399	$0	$10,906	$0	$79,493	$0
Net	($26,063)	$(40,020)	($81,096)	($64,000)	$55,032	$0

IMPLICATIONS

Notwithstanding the softness and subjectivity of many of the reported benefits, it appears that introduction of an EMS did frequently have positive observed impacts on the economic performance of these participating facilities. Even though many economic benefits were not quantified, many of these facilities perceived benefits that in the long run might be subject to more quantitative estimation as facilities became more adapt at identifying and tracking changes to their operations and management practices. Clearly, the experiences of those facilities that realized monetary benefits during the study period provide evidence that support this possibility.

While these data offer some degree of optimism for the potential of an EMS to positively impact the economic performance of adopting facilities, we must also acknowledge that more often than not, the monetary costs reported by these facilities to design and implement the systems outweighed the monetary benefits they could document. Since it is evidently difficult to factor perceived but unquantified benefits into this net equation, many organizations may find quantified short-term economic losses difficult to absorb and hard to justify. Ultimately, a broader understanding of what factors are associated with higher net monetary benefits may help to inform both facility managers and policy makers as decisions on EMS adoption and promotion arise.

[115] These costs were reported under the heading “other costs.”

BENEFITS OF ISO 14001 REGISTRATION

One further consideration is whether facilities experienced monetary benefits associated with registration of the EMS to the ISO 14001 standard. For facilities that chose to design their EMS to the ISO standard and to pursue third-party registration of it, one might expect that net monetary benefits would be different due to the additional costs of registration and auditing fees. Conversely, one might also expect that the additional scrutiny of outside observers might push the facility to design a system that was capable of extracting real economic benefits from the program.

However, the results showed no statistical differences between the net monetary benefits observed at facilities that were registering their EMS to the ISO standard ($40,200) and those without registration intentions ($40,020). Similarly, non-registering facilities were no less likely to have reported at least one quantifiable or unquantifiable benefit (14 of 19 facilities) than were registering facilities (16 of 18 facilities).

BENEFITS AND ADOPTION MOTIVATIONS

A question that runs throughout this report concerns the motivations of facilities to adopt EMSs. We have found consistently that factors which drive adoption decisions encompass a wide range of considerations (Chapter 6) and do indeed have some association with environmental performance outcomes (Chapter 10) and with design costs of the EMS (Chapter 11). Furthermore, the real possibility exists that organizations which are adopting EMSs may be doing so in anticipation of accruing economic benefits, whether through reduced costs of their environmental impacts or through market forces.

To investigate the associations that might exist between benefits and adoption motivations, we examined both reported net monetary benefits and the total number of non-quantifiable benefits reported by these facilities in light of the model articulated in Chapter 6 and Chapter 10 respectively. Few associations were observed between net monetary benefits and facilities' adoption motivations. Interestingly, facilities that rated a desire to increase revenues higher in the adoption decision matrix achieved more impressive net monetary benefits than those that did not ($r=0.47$, $p<0.01$). This offers preliminary evidence that facilities expecting some economic benefit from EMS adoption realized these savings.

However, total benefits at those facilities motivated by revenue concerns were statistically the same as at those rating increased revenues less important in their decision making process. Costs of EMS design and implementation, however, were substantially lower ($p<0.05$) at revenue-motivated facilities (averaging $58,705) than at non-revenue motivated facilities (averaging $112,409). These results seem to imply that instead of garnering greater benefits from their EMS, facilities that anticipated monetary benefits instead held the line on design and implementation costs. This result is consistent with the fact that nearly all observed benefits at these NDEMS facilities resulted from *reduced costs* rather than increases in facility revenues.

Table XII-4 displays the correlation coefficients for significant associations between the various motivating factors and total net monetary benefits, along with the mean net monetary benefits of facilities rating the consideration medium or high and those rating the consideration low.

TABLE XII-4: ASSOCIATIONS BETWEEN MOTIVATIONS AND NET MONETARY BENEFITS

Sources of Motivation	Correlation with net Monetary Benefits	Mean Benefits for Facilities rating High	Mean Benefits for Facilities rating Low
External Motivator			
Market (n=32)			
Domestic customer pressure to adopt	0.14		
International customer pressure to adopt	0.19		
Use of EMS as a marketing tool	0.29		
Potential competitive advantage from adoption	0.30		
Professional support for EMS adoption	0.04		
Shareholders/owner pressure	0.05		
Cost reduction	0.11		
Increased revenues	0.47***	($21,210)	($76,000)
Regulatory (n=32)			
Baseline violations observed	0.15		
Baseline non-compliances observed	0.28		
Improved compliance from EMS adoption	0.04		
Possible regulatory benefits from EMS adoption	-0.09		
Availability of government assistance	0.17		
Social (n=32)			
Inquires from outside parties baseline	-0.06		
Outside parties request for EMS adoption	-0.08		
EMS adoption as a public relations tool	0.12		
Internal Motivator			
Capabilities (n=32)			
Ownership	-0.19		

***$p > 0.05$

The benefits that were described by NDEMS facilities but were not quantified evidenced a greater number of associations with facility motivation than did their reported monetary benefits. As with net monetary benefits, more unquantified benefits were observed at facilities that rated the potential of the EMS as a source of increased revenues more important in their adoption decision matrix ($r=0.39$, $p<0.02$). Similarly, greater numbers of unquantified benefits were observed at facilities motivated by pressures from domestic customers ($r=0.49$, $p<0.01$). For instance, facilities that rated potential increases in revenue as a high or medium motivating factor in their adoption decision (n=13) were more likely to report unquantifiable benefits from reductions in liability ($p<0.02$) and improved regulatory relationships ($p<0.02$). Illustrating the differential affect of motivation on unquantified benefit observations were those facilities motivated by pressure from domestic customers to adopt an EMS. These facilities (n=10) were more likely than were facilities that rated this pressure less important to

report unquantifiable gains in operational efficiency ($p<0.001$) or not surprisingly improved customer/supplier relations ($p<0.01$). The results are presented in Table XII-5, below.

TABLE XII-5: SIGNIFICANT DIFFERENCES BETWEEN MOTIVATIONS AND UNQUANTIFIED BENEFITS*

Benefit Observed	Reduced Liability		Improved Regulator Relations		Increased Operational Efficiency		Improved Supply Chain Relations	
Motivator	***Y***	***N***	***Y***	***N***	***Y***	***N***	***Y***	***N***
Number of Facilities Reporting Benefit								
Increased Revenue: Hi	10	03	08	05	n/a	n/a	n/a	n/a
Increased Revenue: Lo	07	17	09	15	n/a	n/a	n/a	n/a
Domestic Pressure: Hi	n/a	n/a	n/a	n/a	10	00	04	06
Domestic Pressure: Lo	n/a	n/a	n/a	n/a	15	12	02	25

*This table reports responses for which there were statistically significant differences ($p<0.05$) between dichotomous or categorical variables in independent samples (e.g., facility rated motivator high and facility reported non-quantified benefit x) using Fisher's Exact Test.

What these results appear to show is that motivations play a role in the benefits observed at these facilities. Motivations necessarily frame and inform expectations. As such, the benefits a facility expects to gain from adoption of an EMS at their site may direct where and how benefits are perceived and tracked.

This pattern is by no means complete. If motivations and expectations are indeed central considerations in the benefits facilities might expect to receive from EMS adoption, a number of important associations are missing. The most salient gap is the lack of relationship between facilities highly motivated by the potential of the EMS to reduce costs and these observed benefits. Consider for instance that 87 percent of the total quantified benefits observed at these facilities were directly related to reduction in the costs of waste disposal, materials use and fines. However, for facilities that reported quantified benefits and also rated reduction of costs important in the adoption decision (16 of 32 facilities), observed benefits were not statistically higher than at other facilities.

Furthermore, while more than half of the NDEMS facilities reported non-quantifiable benefits from improved regulatory relationships, facilities that considered the potential for improved regulatory compliance important to their adoption decision were no more likely to report benefits of this nature than were other facilities. These considerations are particularly relevant for policy makers as they attempt to balance benefits to the public good of environmental protection and improvement with the motivations and expectations of facility and organizational management.

CONCLUSIONS

The results of our investigation of the benefits reported by these NDEMS facilities allow us to draw some initial conclusions on the economic impact of EMS adoption at these sites.

First, there is evidence to suggest that introduction of an EMS does indeed make an observable difference to the economic performance of these facilities. Both benefits and costs associated with EMS introduction were widely reported, both perceived and in some cases quantified.

Second, the benefits most frequently reported were related to reductions in operational costs such as waste disposal and generation and materials use. Others included cost reductions associated with improved management efficiency, with reduction of liability and insurance costs, and with improved relationships with regulators. Actual increases in revenues were rare, at least for these facilities and in this initial time period. There was ample evidence however that an EMS could help to reduce some costs associated with negative environmental impacts, which benefited both the facility and, through lower volumes of waste and material use, the environment.

Third, however, the far more limited benefits that were quantified suggest that with a minority of exceptions, for most facilities the quantified costs outweighed the quantified benefits they could document.

These results also support prior findings which suggest improved management efficiency as one real, though difficult to quantify, benefit of EMS implementation. Facility perceptions of increased regulatory performance (supported additionally by our findings in Chapter 10) and reduced liability were potential sources of additional monetary savings, should facilities be able to specify and monitor these benefits. Finally, we were able to offer an empirical model for evaluating the economic consequences associated with EMS design and implementation for future investigation.

Chapter 13. EMSs in Government Facilities

INTRODUCTION: WHY A SEPARATE CHAPTER ABOUT GOVERNMENT FACILITIES?

Environmental management systems (EMSs) were developed primarily by for-profit businesses, such as publicly traded corporations and privately owned firms. Relatively few government facilities in the US have introduced EMSs as yet, and even fewer have adopted comprehensive EMSs for all of their operations. At the federal level, however, President Bush has reaffirmed President Clinton's Executive Order requiring EMSs for "appropriate facilities" of all federal agencies. The chairman of President Bush's Council on Environmental Quality has since contacted the heads of government agencies to promote EMS implementation.[116] Some federal agencies, such as the Department of the Army, have responded with department-wide policies committing to the introduction of EMSs, but most so far have introduced them in a few facilities at most, if at all.[117]

EMSs have not yet become a mainstream interest of such government professional and technical assistance organizations as the International City Management Association, National League of Cities, National Association of Counties, or others.[118] However, a growing number of states have introduced initiatives promoting and rewarding EMS adoption by regulated facilities, although few have adopted programs promoting their use by state and government facilities themselves.

After the adoption of the ISO 14001 international voluntary standard in 1996, the U.S. Environmental Protection Agency sponsored the first of two initiatives to help local governments test the applicability and benefits of an EMS for environmental performance, compliance, pollution prevention, and stakeholder involvement in government facilities. This initiative was developed in cooperation with the Global Environment and Technology Foundation (GETF) (Herron, 2002). Nine facilities participated in the first municipalities pilot group, and the enthusiasm and environmental benefits they experienced led the EPA to support fourteen more in a second round. The overarching conclusion of these endeavors was that EMSs can be an innovative and effective environmental management tool for government

[116] See Chapter 1.

[117] However, federal public entities such as the post office, NASA bases, Department of Energy laboratories, and Department of Defense bases, as well as municipal, county and state facilities have received benefits from EMS implementation. The Department of Defense uses EMS to proactively address safety, security, environmental compliance and health issues (Leavitt and Wassersug, 2001).

[118] An exception is the Council of State Governments, which has helped to promote EMSs in cooperation with the Multi-State Working Group on EMSs.

organizations. The EPA, therefore, has helped to create and continues to support the PEER Center, an on-line information and training resource on EMSs for local governments.[119]

As public-sector interest in EMSs grows, one of the objectives of the NDEMS research program has been to gain a greater understanding of the unique motivations, barriers and benefits associated with introduction of EMSs by government organizations. Approximately one-quarter of the NDEMS study population were government facilities, many of which were participants in the GETF pilot program. Data about these facilities have been included throughout the different chapters of this report. This chapter consolidates the government-facility-related findings of this study, and also incorporates supplementary information from the GETF initiatives to provide a clearer understanding of the motivations for and impacts of EMS introduction in government facilities.

ACTIVITIES AND MANAGEMENT OF GOVERNMENT FACILITIES

Government agencies and public enterprises affect the environment through their provision of a wide a range of activities, products and services. Examples include the direct multiple-use management of public lands and waters; electric power production; construction and maintenance of highways and buildings; the use of large fleets of motor vehicles; the management of municipal wastewater and solid wastes; the waste streams of public hospitals, universities, and energy and nuclear research facilities; and the development and use of military bases, military training and warfare, and weapons of ecological destruction. While some of these functions may be contracted out to private firms, government agencies write and administer the contract terms and regulations under which these activities are carried out, and thus remain ultimately responsible for their environmental impacts.

Like private businesses, many governmental units historically have treated their environmental impacts as side effects or mission constraints, to be managed only to the extent necessary for compliance with environmental regulations. At least among the NDEMS pilot facilities, most government facilities also had far more limited pre-existing capabilities and resources for environmental management than private-sector businesses, particularly as compared to subsidiaries of publicly traded corporations.

More than private or publicly traded businesses, many government units also are directly responsible for environmental goals as one of their core missions, rather than merely as a subsidiary dimension or constraint on a core mission to produce profits. Federal, state and local parks and recreation departments, fish and wildlife agencies, water and waste management authorities, environmental and occupational health bureaus – all are examples of government units that are specifically responsible for achieving environmental missions and goals. An EMS for such an organization might be used not merely to improve regulatory compliance or eco-efficiency, but as a primary management document for achieving public policy goals for the environment and carrying out the organization's central mission.

Government agencies also are in the unique position that they both regulate and are regulated under environmental laws. From the federal EPA to state and local environmental regulatory

[119] www.peercenter.org

agencies, government units have environmental impacts not only through their management of their own facilities and operations but also through their regulation and enforcement of others' facilities.

In short, government facilities have at least as diverse a range of environmental impacts and influences as do private-sector businesses, including some environmental responsibilities that are intrinsic to their missions as well as others that may be poorly managed and have problematic side effects. Managers of government facilities and activities are thus responsible for a broad range of environmental performance impacts and for compliance with – as well as enforcing – a large number of federal and state regulations. In this context, management must constantly balance services provided with reduced budgets while maintaining compliance, and also while sometimes competing against private enterprises offering citizens cheaper, better, faster and, more frequently, greener services (GETF 1998, 2002).

Many public sector entities, which should ideally be role models for their communities, lack the resources and management capabilities to deal effectively with the diverse and complicated environmental issues for which they are responsible. The political context of public-sector facilities and activities often constrains their environmental management options and incentives in ways that are different but equally problematic from those of private-sector businesses.

Private-sector facilities are constrained by market competition and shareholder expectations from pursuing environmental goals and management options beyond their profitability. Government agencies are constrained by legislated limitations on their options, and budgetary constraints on their resources, from pursuing environmental goals and management options beyond their statutory authority. Some government accounting procedures often create disincentives for eco-efficient savings (for example, from energy conservation or pollution prevention) by requiring that any savings be returned to the general treasury (and that future budgets for the agency be reduced accordingly) rather than retained by the agency for discretionary reinvestment in its mission. Finally, political pressures both within the organization and from its external constituencies often resist changes that alter the benefits of the status quo. All these factors often hamper effective management, and limit facilities' ability to achieve environmental goals.

In light of these considerations, one might wonder why government organizations such as counties, municipalities and towns would be interested in introducing an EMS. In many ways, however, the distinctive responsibilities and challenges facing government facilities make them particularly appropriate candidates for EMS implementation. An EMS is a powerful tool for addressing the large-scale problems of operating and maintaining physical plant and complex power, water, and transportation systems (GETF, 2002). EMSs can help government owned organizations to address their regulatory demands in a systematic and cost-effective manner. Such a proactive approach can help to reduce the risk of non-compliance, and to improve health and safety practices for employees and the public. EMSs also can help address non-regulated issues such as odor management and energy conservation, and can promote stronger operational control and employee stewardship. Some local government entities also are using EMS to manage growth and in response to privatization concerns in the management of utilities (GETF, 1998). Finally, an EMS can be used as a basis for communication and accountability with the public, and even for public involvement in collaborative planning, by local governments that choose to do so.

Government owned facilities participating in both the EPA pilot projects and the NDEMS study have reported a variety of benefits as a result of their EMSs. Examples include better operational control in areas that impact the environment; better understanding of the root causes of noncompliance; improved operational efficiency and cost savings; improved communication within the organization and with outside stakeholders, contractors and vendors; and better relationships with regulators and stakeholders (Ruberti and Leavitt, 2000).

GOVERNMENT FACILITY DEMOGRAPHICS

Government facilities comprised 27% of the NDEMS study population at baseline. The 22 government facilities that provided baseline data represented a wide range of facility types, including universities, military bases, waste water treatment and transit operations, public services such as parks and lighting, and city and state governments (Table XIII-1). The majority of these 22 facilities were units of local governments, with the exception of public universities and port authorities (units of state governments) and military facilities (units of national government).

By the first update the 8 government facilities still contributing data to the study represented 22% of the total study population. These remaining facilities were a heterogeneous mix of universities, military facilities, water treatment authorities, and local government organizations.

TABLE XIII-1: TYPES OF GOVERNMENT FACILITIES (N=22)

Type	Baseline	Update
University	2	1
Transportation	3	0
Military	2	2
Water treatment	4	4
City government	5	0
State Agency	2	1
Other public service	4	0
Total	22	8

The number of employees covered by the EMSs implemented in government facilities varied greatly, from 25 to 4500 (Table XIII-2). However, the average (258 employees per government facility EMS) was 2½ times smaller than the average number of employees covered by EMSs in publicly traded facilities. More than 90 percent were state or local facilities, and more than 90 percent also classified themselves as units of a larger organization (Table XIII-3).The state and federally owned facilities were larger than the local facilities, and were the only facilities to have an employment base of over 1000 employees.

TABLE XIII-2 : SIZE DISTRIBUTION OF GOVERNMENT FACILITIES

(n=21)

Number of Employees	Number of Facilities	Percent of Facilities
20-49	4	18%
50-99	4	18%
100-299	3	14%
300-999	5	23%
> 1000	5	23%

TABLE XIII-3: GOVERNMENT FACILITY OWNERSHIP STRUCTURE

Ownership Structure	Number of Facilities	Percent of Facilities
Federal	2	9%
State	7	31%
Local	13	60%
Part of a Larger Organization	20	91%
Independent	2	9%

Of the facilities that had over 1000 employees, only one had an EMS that covered the entire facility One-third (33%) of the government facilities' EMSs were applicable to all of the facility's operations, meaning that the majority of EMSs implemented in these facilities did not encompass the full range of their activities or, as a result, their environmental impacts.

The government facilities providing update data were similar in most respects to those that had provided update data (Table XIII-4). Almost half of the 22 government facilities participating in this study at baseline were given a modified version of the NDEMS protocol due to their concurrent involvement in an EPA municipality pilot project. This modified protocol did not ask some of the questions included in the full NDEMS protocol. For example, the municipal pilot project protocol did not ask about the production or marketing of products abroad. Eleven facilities were given protocols that asked these questions, of which none belonged to an organization with international production locations, but 27% belonged to an organization that reports that it markets its products outside the United States.

TABLE XIII-4: GOVERNMENT FACILITY CHARACTERISTICS

Characteristic	Baseline (22)	Update (8)
• EMS Covers Entire Facility	45%	33%
• Avg. Number of Employees	258	258
• Part of a larger organization	86%	88%

DRIVERS FOR EMS PARTICIPATION

Some common external and internal drivers that motivated government agencies to adopt EMSs included improved environmental compliance and performance, better operational control and efficiency, better public image, better relationship with regulators and stakeholders, opportunities for leadership and innovation, growth management, and reducing impact on natural resources (Leavitt and Wassersug, 2001).[120]

External Drivers

Regulatory Pressures

Most of the NDEMS facilities adopted an EMS to improve their compliance with environmental regulations. The majority of government facilities reported that the possibility of compliance improvement had either a high or moderate influence on their EMS adoption decisions. However, the influence of potential regulatory benefits motivated government facilities' EMS adoption decisions more than publicly traded and privately owned facilities. It is unclear why these differences exist, but they may be due to the slightly higher number of regulatory non-compliances and potential noncompliance that government facilities experienced prior to participation.

The traditionally coercive American regulatory system has recently begun to incorporate incentives for good behavior through the use of voluntary environmental initiatives (VEIs) such as environmental management systems. This change has created a more cooperative institutional arrangement for organizations that choose to participate in VEIs. It has also resulted in greater variations in the influence of different regulatory incentives on facility-level decisions to participate in an EMS.

Government facilities participating in the NDEMS study were influenced greatly by regulatory incentives. One of the most important findings related to regulatory drivers was that government assistance programs played an important role in influencing government facilities' participation decisions. Programs such as NDEMS, for example, influenced 88 percent of government facilities' decisions to introduce EMSs. In contrast, receiving government support motivated only 55 percent of privately owned facilities and 11 percent of publicly traded facilities.

Several other regulatory drivers cited by government facilities participating in NDEMS and or the EPA pilot projects are: compliance issues such as specific environmental problems, incidents or fines; improving regulatory relationships; the desire for risk avoidance and risk reduction approaches that will prevent non-compliance instead of responding reactively to compliance issues; and the goal of reducing remediation costs inspired by the realization that it would be cheaper to prevent pollution than to clean it up after the fact.[121]

[120] This information is obtained from the 23 facilities participating in the two EPA municipal pilot projects, not directly from all NDEMS facilities.

[121] GETF, 2002.

Market Pressures

Government organizations typically have less incentives than private businesses to allocate their scarce resources towards achieving greater internal efficiencies, such as the "eco-efficiencies" associated with pollution prevention, energy and water conservation, and other environmentally related cost savings. This is likely in part because most are not compelled by market forces, which demand a certain threshold of organizational efficiency in order to remain in business. It is also likely because government agencies face more difficult and less discretionary approval processes for the capital investments needed to achieve such savings, because any resulting savings benefit only the general treasury rather than the unit that achieves them, and because that unit's budget might even be reduced rather than rewarded as a result of such savings. Another consideration is that given the less direct impact of market forces on government agencies, the implementation of the Government Results Reporting Act might be viewed, at least at the federal level, as an alternative means to provide focus on agency goals, measurement of performance and achievement of efficiencies.

For publicly traded and privately owned facilities EMS implementation is expected to be a useful marketing tool and a means to gaining a competitive advantage, but these two market pressures had a negligible influence on the participation decisions of government facilities, yet these facilities are frequently faced with the need to remain competitive with private industry or privatization operations. However, the specter of potential privatization was a factor in the participation decision of at least one of the wastewater treatment plants in this study. Furthermore, several universities have viewed the implementation of an EMS as an experience enhancing and market/curriculum expanding opportunity.

Social Drivers

For all three types of facilities participating in the NDEMS, social drivers were the least influential. However, government facilities received a greater number of requests for information from stakeholders than the other two types of facilities, and as a result government facilities were more likely than publicly traded or privately owned facilities to have established formal stakeholder groups as a part of their EMS. While government facilities reported that social pressures had little influence on their EMS adoption decision, it appears that the possibility of increased public relations opportunities did moderately influence facilities' EMS adoption decisions. This pattern may be attributable to public image concerns and the desire to improve poor relationships with neighbors and counteract bad press, as a many of the government facilities in the NDEMS have had frequent and or obvious violations of environmental regulations at baseline.

Internal Capabilities

Many kinds of internal capabilities, or the absence of them, are likely to play a role in government facilities' EMS implementation decisions. This study focused on a few of the most prominent of these: non-environmental management systems, continuous improvement capability, environmental management capability, access to resources, and the influences of parent organizations and slack resources. An understanding of government organizations' internal capabilities prior to EMS adoption is important in examining the rationales for their interest in EMSs.

Management System Capabilities

Forty-one percent of the government facilities that provided information (22) had utilized non-environmental management innovations prior to EMS introduction during the baseline period (Table XIII-5). However, government facilities had adopted such management systems less frequently than publicly traded or privately held facilities. These results are consistent with the conclusion that government facilities had the least developed management capabilities of these three facility types prior to EMS introduction.

TABLE XIII-5: NON-ENVIRONMENTAL MANAGEMENT PROGRAMS

(n=22)

Non-Environmental Management Systems	Number of Government Facilities	Average Number of Years
None	12	-
ISO 9000	0	0.0
Total Quality Management	4	8.3
Materials Accounting	2	5.0
Just-in-Time Inventory	1	10.0
OSHA Voluntary Protection	4	4.3
Other	6	2.2
At least one of the above	10	7.5

In particular, no government facilities had a certified quality management system in place prior to EMS adoption, whereas two-thirds of the publicly traded facilities and half of the privately owned facilities had already introduced ISO 9000 systems for quality management and continuous improvement.[122] Because of this preexisting capability, EMS implementation by businesses likely demanded fewer internal resources and was more easily integrated into overall management practices than by government organizations.

Use of a TQM (Total Quality Management) program may be a more relevant indicator for governmental organizations than ISO 9000 (Boyne and Walker, 2002:111). Total quality management is frequently a part of the continual improvement strategy for many public organizations worldwide, and it is commonly held that the ISO 9000 series is simply a more specialized form of TQM (Darnall, 2003). In the cost regression reported in Chapter 11, participation in TQM also was associated with statistically significant reductions in cost while ISO 9000 participation was not. Thus, TQM participation may provide a better comparative picture of management systems experience, and a better indicator for government facilities' non-environmental management expertise.

[122] In certain sectors it may be unlikely that government organizations would have ISO 9000 as compared with organizations which produce or design a tangible product, and such facilities would therefore be at some disadvantage in comparison to manufacturing and product design operations.

Even using TQM rather than ISO 9000 as an indicator, however, government facilities were still at the low end of the comparison for prior management systems experience. Only four of the 22 government facilities (18 percent) reported having a TQM program.

Environmental Management Capabilities

Prior to EMS implementation, government facilities also had developed the least environmental management capabilities of the three facility types. While there were few differences between government, public, and private facilities' participation in pollution prevention activities or adoption of formal pollution prevention plans,[123] none of the governmental entities reported consideration of pollution prevention in their routine business planning. In contrast, 48 percent of publicly traded and 44 percent of privately held facilities reported this practice .

Pre-existing environmental management practices were similar to those for non-environmental management systems. Of the 22 government facilities that provided baseline information, 9 (41%) had utilized one or more voluntary environmental management programs, such as the green lights program, or state sponsored initiatives. However, when compared to the entire study population, government owned facilities were less likely to have participated in these programs than publicly traded facilities.

Sixty-four percent of the government facilities had already introduced at least one environmental management technique, but overall government facilities were less likely to have employed such techniques, or to have utilized more than one of them during the baseline period, than the other types of facilities. Table XIII-6 shows the utilization of the most common environmental management techniques by government facilities during or prior to the NDEMS baseline period.

[123] These results may be due in part to the fact that most of these facilities operated within states that by law required pollution prevention plans.

TABLE XIII-6: PRE-EXISTING ENVIRONMENTAL MANAGEMENT TECHNIQUES

(n=22)

Environmental Management Techniques	Number of Government Facilities	Percent	Average number of years implemented
Waste Minimization Planning	8	36%	6.6
Pollution Prevention Planning	7	32%	5.3
Compliance Auditing	5	23%	2.4
Annual Environmental Report for Internal Use	4	18%	7.5
Environmental Best Management Practices	4	18%	8
Annual Environmental Report Made Public	2	9%	17.5
Environmental Accounting System	0	0	0
Risk Assessment System	0	0	0
Total Quality Environmental Management Adopted	0	0	0
Life Cycle Analysis Performed	3	14%	8.3
Other Techniques/Programs	7	32%	6
At least one of the above	14	64%	19.5

Facilities that participated in voluntary environmental management initiatives and those that utilized multiple environmental management techniques (as described above), were more likely to have established at least one feature of an ISO 14001 EMS at their sites than were facilities that did not. Facilities that reported involvement in pollution prevention activities, and facilities that established formal pollution prevention plans, also were more likely to have at least one feature of an EMS during their NDEMS baseline period (Table XIII-7).

TABLE XIII-7: PRE-EXISTING ENVIRONMENTAL MANAGEMENT SYSTEM FEATURES

(n=22)

Feature	Number of Government Facilities	Percent
Top management has defined the organization's environmental policy	6	27%
Organization has identified its aspects and impacts that can have a significant impact on the environment	5	23%
Organization has a procedure to identify its legal and other requirements	10	45%
Organization has established documented environmental objectives and targets	5	23%
Organization has set a time frame for achieving its objectives and targets	4	18%
Organization has a planned method achieving its objectives and targets	3	14%
Organization trains its employees about the EMS	4	18%
Organization has procedures for receiving communication from external interested parties	12	55%
Organization has procedures for documenting communication from external interested parties	7	32%
Organization has procedures for responding to communication from external interested parties	9	41%
Organization has documented core elements of EMS	5	23%
Organization has documented procedures for monitoring and measurement	5	23%
Organization conducts internal EMS audits	6	27%
Organization hires an external auditor to audit its EMS	4	18%
Organization's top management reviews the EMS periodically	1	5%
Organization did not have any EMS features	4	18%

Government organizations would be expected to be especially likely to have procedures for identifying legal and regulatory requirements, for receiving communication from outside parties, and for responding to communication from outside parties. These emphases may reflect government organizations' sensitivity to legal and public accountability considerations. Even these EMS features, however, were reported as being present in less than 55 percent of government organizations.

Access to Resources and the Impact of Parent Organizations

Approximately 87% of the government facilities in both the baseline and the update databases were a part of a larger organization. Facilities associated with a larger organization may have very different motivations for adopting an EMS than independent facilities, and they are likely to face distinct challenges such as planning for longer lead times in decision making or centrally determined priority-setting, cost-accounting, or control systems (Darnall, 2002).

The support that government facilities received from their parent governmental organizations was expected to be lower than for publicly traded enterprises, because governments in general

have not yet mandated or promoted EMS adoption by their subsidiary units.[124] In combination with lower overall internal capabilities, less parent-organization support was associated with both a lower rate of adoption of EMSs and a greater reliance on assistance from consultants and other external sources during EMS design and implementation.

Twenty percent of government facilities received EMS technical assistance from their parent organizations, however, none were provided with the EMS templates that more than two-thirds of the corporate facilities received from their parent organizations. The lack of support provided by the parent organizations of government facilities may in part explain the large expenditures of these facilities on consultant services. Eighty-three percent of the NDEMS government facilities considered these additional resources of "high" or "medium" importance. These results offer strong evidence of government facilities' reliance on external resources.[125]

Fifty percent of the government facilities that completed this study through the first and second updates had registered their EMS to ISO 14001 or were seeking registration.[126] The influence of facilities' parent organizations was associated with some of the differences between facilities' propensity to register their EMSs. Sixty-six percent of the independent government facilities registered to ISO 14001, compared to only 40 percent of those that were units of a larger government organization (Table XIII-8).

TABLE XIII-8: GOVERNMENT FACILITIES AND ISO 14001 CERTIFICATION

Facility Type	**Facility with Parent Organization**			**Single Facility**		**Total ISO Certified Facilities[a]**
	Total	*ISO 14001*	*Parent Requires or Encourages EMS*	*Total*	*ISO 14001*	
Government (8)	62% (5)	40% (2)	20% (1)	38%(3)	66% (2)	50% (4)

[a]- Denotes those facilities that were certified to ISO 14001 or were seeking third party certification to ISO 14001. Facilities that declared 'self-certification' or did not utilize third-party registration were excluded from these counts.

Of the facilities participating in this study, government organizations had the fewest available resources, with less encouragement for EMS adoption by the parent entity and fewer technical assistance resources once the facility began development of the system. These facilities' expenditures on consultant services in designing their EMSs, and the importance they attributed to assistance programs, further illustrate the more limited internal resources and capabilities available to government facilities for EMS development compared to publicly traded or privately held businesses (Table XIII-9).

[124] At the federal level, the Clinton Executive Order and the Bush administration's endorsement are exceptions, but their deadlines for EMS introduction had not yet approached by the time of this study.

[125] As was previously noted, a variety of incentives including monetary grants were offered to facilities participating in the NDEMS study. Several privately held facilities that reported consultant use during EMS design did not report costs associated with these services: these facilities noted in their cost reports that their consultant costs were subsidized by state grants.

[126] All of the government facilities (8) that completed the first update also completed the second update.

TABLE XIII-9: INTERNAL CAPABILITIES

Variable	Publicly Traded	Privately Held	Govern-ment
Management System Capability			
Adopted TQM practices	0.48	0.31	0.00
ISO 9000 Certified	0.71	0.63	0.00
Adopted a QMS	0.90	0.63	0.00
Implemented Other Mgmt System	0.76	0.50	0.00
Environmental Mgt. Capability			
P2 activities	0.86	0.88	0.67
P2 plan	0.62	0.50	0.33
P2 in business planning	0.48	0.44	0.00
Advanced EM techniques	0.81	0.25	0.17
Access to Internal Resources			
Existence of parent organization	0.90	0.69	0.83
- Parent provides tech. assistance	0.68	0.27	0.20
- Parent provides EMS template	0.68	0.18	0.00
- Parent encourages or req. EMS	0.84	0.64	0.20
- Any parent organization support	0.95	0.27	0.20
Use of consultants in EMS Design	0.33	0.69	0.50
Rated government assistance medium or high importance	0.10	0.44	0.83

Other Drivers

Government facilities participating in the NDEMS and GETF pilot groups also highlighted motivations for EMS implementation that fell outside the context of the internal and external drivers outlined above. Organizational factors such as better efficiency, worker health and safety concerns, employee morale, and reduced costs were common issues that motivated facilities towards EMSs. Growth issues such as the goals of promoting smart growth, reducing sprawl, led some state and local governments to view an EMS as an incentive to attract the right type of industry and send a message that their area had a strong environmental consciousness. Many facilities also aspired to leadership roles in innovative programs, and wanted to play a stronger role in leading and mentoring their communities in environmental stewardship initiatives, and responsible economic development.[127]

Overall, the results in this section confirm that regulatory drivers were important influences on government facilities' decisions to participate in the pilot program, and that deficiencies in pre-existing management capabilities and resources tended to handicap them in their EMS introduction processes,

[127] GETF, 2002

BARRIERS

As noted above, government facilities participating in the municipality and NDEMS pilot projects experienced significant and distinctive barriers to the success of their initiatives. GETF assessments attributed many of these challenges to management issues such as the challenge of integrating new approaches into strongly bureaucratic organizations; insufficient leadership; lack of visibility and involvement from top management; organizational problems such as time and employee buy-in, lack of public awareness understanding and buy-in; and political uncertainty (Ruberti and Leavitt, 2000).

Managing Organizational Change

EMS implementation often requires a fundamental change in how an organization addresses its environmental issues. As a facility develops programs that build environmental stewardship and improve management of environmental obligations, strategies also are needed to overcome human and organizational resistance to change. Several of the drivers of this resistance to change were identified by NDEMS and GETF pilot project participants.

For example, in some organizations knowledge is not always readily shared: a documented management system can be threatening to employees who have acquired considerable knowledge that sets them apart from others. A larger motivational barrier in dealing with environmental issues is the common attitude that "no news is good news, good news is no news," an outlook which does not encourage the proactive approach that is inherent in the EMS framework. The standard reactive responses to environmental issues when they do occur has also tended to produce one or two 'heroes' per incident, and overcoming this "firefighting" mentality can be challenging.[128]

Lack of Top Management Visibility and Support

The process of restructuring facility standards and practices, particularly when it requires increased cooperation and time from many employees, requires the active leadership and visibility of top management. In the words of an EMS practitioner from one study facility, "management needs a better grasp/understanding of what an EMS entails and of their role in the EMS process before making a decision to implement it because the changes that are a part of an EMS require top management leadership and visibility and personal involvement, not just lip service."[129]

Lack of Public Awareness Understanding and Buy-In

So far, there generally is little public awareness of the use of EMSs by government facilities. Corporations usually are the focus of media attention and public controversies over environmentally negligent management practices, and with some exceptions, there is generally far less public and media attention to the environmental practices of government

[128] GETF Final Report

[129] GETF, 2002

facilities.[130] The result is that there is generally little public knowledge, interest or appreciation for government facilities that adopt EMSs. This lack of public awareness makes it difficult to prioritize the EMS in the budget process, because in these government facilities public demand, if it existed, would presumably be one of the strongest drivers for EMS implementation. This lack of public demand is due, in part, to the lack of communication of EMS benefits to the city management or public. Without the communication of benefits, EMS introduction may also be hampered – particularly at the state and local level – by assumptions that it would merely add costs and paperwork at extra expense to taxpayers.

Political Uncertainty

The organizational structure of government organizations makes them subject to the changing politics of local, state and national governments. If a supportive senior administrator leaves or a new official or government is elected, the facility must often go back to their parent organization or the incoming management and educate them once again about the EMS to regain support for the initiative. This issue is of particular concern when an EMS is not yet institutionalized and a new administration is elected: in this situation some facilities have worried that the EMS might be seen as merely a pet project of the previous regime, rather than a core management practice of enduring value.[131]

Organizational Issues

GETF's final report on EPA's first public-sector pilot project included testimonials from employees at the study facilities, highlighting organizational issues that created barriers for successful EMS implementation. These included the steep learning curve, frequent management changes, downsizing, staff streamlining, and employee changes in the implementation team, all of which made the process more challenging. Moving beyond the planning stage and integrating the EMS approach into existing systems also was difficult due to a lack of understanding and buy-in throughout the operating unit. Getting first tier management buy-in and cross-functional responsibility for EMS implementation was also a challenge; time was very limited, and there was an erroneous perception that the EMS could be accomplished above and beyond normal work duties; the EMS implementation team often was given the responsibility but not the authority needed to facilitate implementation; and establishing and maintaining a paper trail of consistent processes, procedures, and records was time consuming.

For many of these facilities these barriers were able to be resolved through increased management leadership, understanding and involvement in the EMS process, as well as building on existing organizational processes and procedures. Other important lessons learned by overcoming barriers to EMS implementation were the importance of selecting an implementation team that included cross-functional representation and support and that had the acceptance and involvement of employees throughout the organization.

[130] Obvious exceptions include a number of federal military and nuclear facilities, and particularly in the West, controversies involving federal land and water management practices. Controversies over environmental management practices of state and local facilities generally are both less frequent and less visible.

[131] GETF, 2002

BENEFITS

Even though the process of implementing a successful EMS was fraught with barriers, a majority of the NDEMS government facilities reported benefits from the introduction of their EMS.[132] While most of the government facilities in the NDEMS and EPA pilot projects did not initially consider safety and economics as major drivers for EMS implementation, they found significant unexpected benefits in these areas. New drivers for EMSs in the government sector included financial benefits (higher bond ratings, cheaper insurance policies), heightened efficiency, and improvements in operational controls. The varied benefits described by these government facilities can be summarized in six broad categories:

- increased management and employee efficiency
- increased operational efficiency
- improved community relations and improved customer/supplier relationships,
- reduced liability
- regulatory benefits
- improved environmental performance

The first four of these benefits categories resulted from key changes in facility management after EMS adoption. Examples highlighted in the GETF final report included

- increased managerial knowledge about operations
- technical and personnel issues
- monetary savings via systematic analysis of compliance issues
- relatively quick learning and implementation of efficient management tools for defining environmental priorities and responsibility
- development of performance partnerships with other organizations
- increased ability to prioritize and defend resources needs.

Overall, these facilities' EMSs provided a better understanding of what each facility is required to do and the means to do it consistently, competently and efficiently.

Reduced Liability

Managers of government facilities often have difficulty anticipating and reacting to low-probability, high-consequence events. EMSs utilize a proactive approach to bring many factors associated with risk into light (Leavitt and Wassersug, 2000). In response to recent evidence supporting the environmental performance benefits of EMSs, the insurance industry is investigating whether (and if so, how) they should recognize the value of an EMS in reducing liabilities, perhaps through a positive impact on insurance rates or providing other

[132] Information derived from Chapter 12.

incentives (Leavitt and Wassersug, 2000). As many municipalities have to bid for insurance, rewards for EMS adoption from insurance brokers would encourage more governments and public utilities to consider EMS utilization.

One of the government facilities participating in this study, for instance, was able to negotiate a five-year commitment instead of the previous one-year commitments with their insurance provider after implementation of their EMS. The insurance broker's reasoning was that an EMS was a recognized tool that gave this facility more predictability in managing their affairs (Leavitt and Wassersug, 2000). Previously the insurance firm's biggest challenge had been getting all of the facility's information to auditors. In addition to providing a structure that addressed this challenge, the EMS helped the facility to reduce its emergency response time from days to hours, making it less of a liability.

The general view of the insurance industry is that environmental risks are caused by "unknowns and the big ugly surprises" (Leavitt and Wassersug, 2000). The findings of this study and of the EPA municipal EMS pilot projects, as well as the experiences of EMS public entity practitioners, suggest that EMSs may decrease the number, frequency, and magnitude of unpleasant environmental "surprises." Furthermore, EMS adoption has provided some facilities with the opportunity to reshape their interactions with regulatory agencies, decreasing the likelihood of confrontational experiences and increasing participation in mentoring and partnership interactions. These facilities reported to GETF that their state had been much more supportive in general and quicker to provide technical support.

Improved Awareness and Performance Improvement

One of the most fundamental benefits government facilities experienced from EMS implementation was an improved environmental awareness, involvement and competency throughout the facility, not just in the environmental department. The recognition of simple internal housekeeping measures that have positive effect on environment performance, and the introduction of additional self-imposed requirements to help prevent pollution and reduce energy use, also were frequently cited as environmental benefits.

Other environmental benefits reported by government facilities included better trained employees; better knowledge of operational hotspots, and increased investigation into the root causes of noncompliance; a sense of increased control over environmental issues, as opposed to responding reactively; more consistent methods for seeking to eliminate causes of violations and prevent future occurrences; and the ability to carry out environmental protection in areas where EPA doesn't have regulatory programs, but which were significant concerns to their citizens.[133]

[133] GETF, 2002

ECONOMIC COSTS AND BENEFITS

Costs of EMS Adoption[134]

Organizations with stronger internal capabilities may incur fewer costs than organizations with weaker internal capabilities because they are more proficient in other management techniques that may facilitate EMS design and implementation. Enterprises with stronger internal capabilities may also be likely to have access to additional resources that mitigate their EMS adoption costs. Government facilities had the highest EMS adoption costs of the three facility types, and these costs appeared to be associated with their lower levels of internal resources and capabilities. Compared to privately owned and publicly traded facilities, government facilities in this study experienced the highest total costs per employee ($1,441) to design and implement an EMS.

Labor was the most expensive component of designing an EMS for all types of NDEMS facilities, accounting for more than half of the average total costs. Labor costs for government facilities, however, were 2.6 times more than privately owned companies' costs. Interestingly, when comparing the percent of total spending allocated to labor, government facilities were similar to private companies in that they spent over half of their average total costs on staff time.[135] They differed, however, in that the government facilities relied on consultants to a much greater degree, investing approximately $499 per employee (36.3 percent of their average total cost).

Economic Benefits[136]

Few government facilities reported quantified economic benefits attributable to EMS introduction. The savings that were reported were of three types: reduced waste disposal costs, reduced fines, and reduced water costs.

Although direct financial savings were not yet a clear benefit of EMS implementation for government facilities, they did report a number of unquantified benefits that have a strong likelihood of eventual economic benefits. For instance, some facilities reported using EMS workflow diagrams and significant aspect analyses to identify operational hotspots where an accident might occur, and to develop new procedures to reduce the probability of these incidents. Staff and management were also able to develop a more comprehensive understanding of their potential exposures, and with reduced liability the asset value of the facility was increased. The EMS thus provided a consistent process and tools to assess and reduce environmental liabilities, potentially reducing insurance premiums, improving municipal bond ratings (which offers a major financial incentive to a community), and increasing the value of municipal assets.[137]

[134] Information in this section derived from Chapter 11.

[135] GETF (2002) also reported that government facilities spent over half of all EMS design costs on labor.

[136] Information in this section derived from Chapter 12.

[137] GETF, 2002

CONCLUSION

An EMS provides government facilities with a dynamic and flexible framework for managing their environmental missions, obligations and risks more effectively. Information collected from the public-sector pilot facilities indicates that EMS implementation integrates well with existing compliance, health and safety programs and provides government owned facilities with additional incentives and management tools to meet regulatory and compliance responsibilities. Where prior to EMS adoption organizations had described their environmental goals primarily in terms of compliance with environmental laws and regulations, after EMS implementation many facilities began seeking opportunities to prevent pollution, to reduce the demand side of their operations, and to initiate programs for non-regulated issues like odor management and energy efficiency.

EMSs have been shown to be applicable to operations managed by state and local governments as well as federal facilities. The reported impact of EMS implementation in government facilities was positive, despite relatively few documented quantifiable economic benefits. NDEMS participants found their EMSs to be a useful tool for managing environmental issues, promoting compliance and pollution prevention approaches, increasing environmental awareness and stewardship, and improving operational control and efficiency. Overall benefits included better operational control, better understanding of the root causes of noncompliance, improved operational efficiency and cost savings, improved communications within the organization and with outside stakeholders, and better relationships with regulators.

Keys to successful EMS implementation in study facilities included management leadership understanding and involvement in the EMS process, building on existing organizational processes and procedures, selecting an implementation team that had cross-functional representation and support, and acceptance and involvement from employees throughout the organization.

The costs associated with implementing EMSs, although significant, were primarily from increased labor hours of the workforce and the hiring of external consultants, both of which could be anticipated to diminish over time as each facility became more adept at implementing their EMS. Other barriers to EMS adoption included management issues (integrating new approaches in strongly bureaucratic organizations); insufficient leadership, visibility and involvement from top management; organizational issues (time, employee buy-in); lack of public awareness; understanding and buy-in; and political uncertainty.

FURTHER RESEARCH ON EMSS FOR PUBLIC FACILITIES

The NDEMS pilot study was conducted during a period in which public-sector facilities were just beginning to introduce EMSs, and they represented only a small fraction of its participating facilities. Many of these facilities also represented only single examples of particular facility types, such as universities and military bases. Accordingly, NDEMS did not have enough participating government facilities, or large enough samples of particular categories of government facilities, to fully examine the distinctive issues, opportunities, costs, benefits, and barriers associated with public-sector use of EMSs.

This is a topic that now deserves fuller examination in its own right. The NDEMS findings suggest that there may indeed be significant benefits of public-sector use of EMSs, and that these possibilities – as well as their costs, and success factors for different types of government facilities – should be more fully examined.

Many major categories of government facilities, activities and services, for instance, have common and predictable types of aspects and significant environmental impacts that could be significantly improved through the use of EMS procedures. Obvious examples include motor pools, construction and maintenance operations, water supply and wastewater treatment facilities, schools, universities, hospitals, and others. Improvements in the environmental performance of such facilities might well have significant benefits both to environmental protection and to the costs of operating and maintaining such public functions.

The costs and other barriers to EMS introduction for such facilities could perhaps be significantly reduced through the use of government EMS assistance programs to provide widely-applicable EMS templates for such facility types, thus helping to fill a parent-organization assistance role that has been valuable to private-sector facilities but largely lacking so far for government facilities.

Some other government units, especially at the federal and state levels, also have distinctive environmental management missions and responsibilities less commonly found in the private sector, for which EMSs might provide a framework worth consideration. Possible examples might include multi-purpose management of public lands and waters and management of other common-property resources such as fisheries, wildlife species and ecosystems. Further studies and perhaps experiments would be useful to explore and evaluate these possibilities.

Government facilities also face different incentives and constraints than private-sector organizations, which may affect both their adoption and their successful and const-effective use of EMSs. Government organizations are often said to be less regulated than private enterprises in similar situations, and some of the NDEMS government facilities also appeared to have less compliance and performance improvement than private-sector facilities. Does this mean that government facilities are under less pressure to adopt EMS due to lesser regulatory pressures? Or alternatively, that greater regulatory pressures on government facilities would increase EMS adoption and performance improvement? Or would government facilities' EMS adoption and performance be best improved by increasing their internal capabilities, such as through increased access to government technical assistance resources, EMS templates, pollution-prevention planning assistance, and other resources?

Finally, all federal facilities are now under Executive Order mandate to consider the introduction of EMSs, and their experiences deserve comparative evaluation to identify the most promising and cost-effective models for more widespread adoption.

Chapter 14. Lessons from Attrition

COMPLETION OF PROTOCOLS

Over the five-year period from the initial Baseline Protocol to the EMS Design and First and Second Update Protocols, the number of facilities providing data gradually diminished from 83 facilities to 58 (EMS Design), 37 (First Update) and ultimately 30 (Second Update). Attrition is a normal problem in longitudinal studies, and especially so in a study that lasts for as long as five years and involves repeated voluntary submission of detailed information. It is nonetheless important to examine its patterns, for three reasons. First, it is important to identify any selection biases affecting the inferences to be drawn from the study (for instance, was attrition random or did it disproportionately involve high or low performers or public- versus private-sector facilities). Second, it would be valuable to determine whether the attrition was solely from the burdens of the study itself, or whether it also reflected attrition from the EMS introduction and improvement process itself. Finally, it is informative to try to identify any patterns of reasons associated with attrition, particularly as they may affect EMS adoption and continuity of commitment to the EMS framework.

The attrition analysis in this chapter focuses on 69 facilities that submitted Baseline Data in cooperation with the ten state Pilot Programs.[138] Data for this analysis were drawn from the research staff's communications with the facilities, and from additional information provided by the state Pilot Program managers based on their knowledge of the facilities' participation history.

Figure 14-1 shows the number of pilot program facilities completing each protocol. Seventeen of the 69 facilities dropped out after the Baseline Protocol was completed, leaving 52 of these 69 facilities that continued on in the study. Sixteen more dropped out after completing the EMS Design Protocol, leaving 36 that completed the First Update Protocol. Finally, 6 more dropped out of the study after completing the First Update Protocol, leaving 30 that completed the entire cycle through the Second Update Protocol. This chapter presents our investigation of the potential relationship between completion of the protocols and several potential reasons for not completing them.

[138] That is, omitting the remaining 14 facilities (of the original 83) that either submitted data only through the EPA/GETF municipalities study, or that had no state program affiliation (four facilities). These facilities are omitted because in the absence of a cooperating state agency, it was not possible to obtain follow-up data on their reasons for attrition.

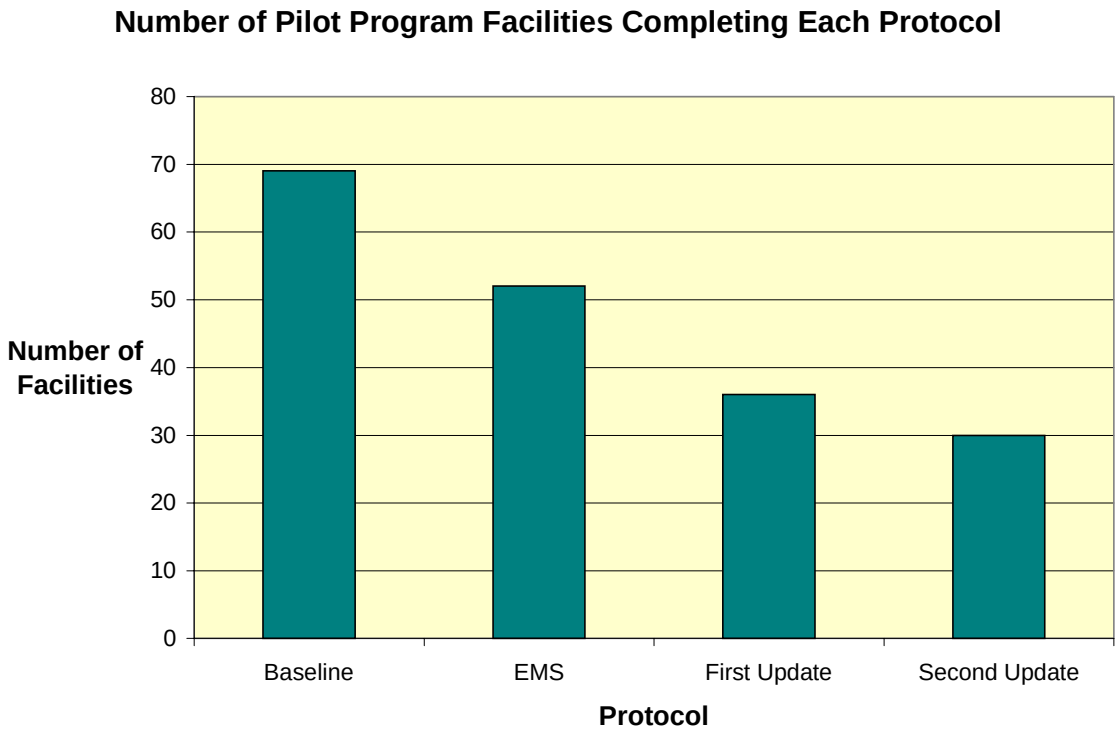


Figure XIV-1. Participation by Protocol For Attrition Sample of Pilot Program Facilities.

ATTRITION AS AN INDICATOR

Whenever a facility did not return a protocol, the research staff made repeated attempts to follow up, first to try to assure completion and maintain the highest possible response rate, and failing that, to ascertain the facility's reasons for not doing so. Anecdotally, many reasons appeared to be associated with changes in the management or operations of the facilities, suggesting that such changes might have impacts not just on participation in the EMS Pilot Program but perhaps also on the fate of the EMS itself. Facilities reported substantial changes in management and personnel, for instance, including buyouts and layoffs, as well as some catastrophic events such as fires and shutdowns. If the observed attrition were an indicator of the facility's lack of continuity of commitment to the EMS, the results might provide insight into the prospects for continual improvement of the EMS within such organizations.

It was also plausible that facilities dropping out of the Pilot Program might have had significantly more adverse events take place during the period of our investigation, and that such facilities would be significantly less likely to have continued working on their EMS after dropping out of the study.

METHODS

For purposes of analysis, six groups of facilities were identified. Group 1 (15 facilities) included those facilities that completed the Baseline Protocol but then dropped out before

completing the EMS Design Protocol.[139] Group 2 (52 facilities) included all facilities that completed both the Baseline and EMS Design Protocols, including both those that also completed the update protocols and those that subsequently dropped out. Comparisons between Groups 1 and 2 focus on the experience of the early dropouts.

Group 3 (31 facilities) included all facilities that dropped out of the study after completing the Baseline or the EMS Design Protocol, before completing either of the Update Protocols (that is, Group 3 included the facilities in Group 1 plus those that dropped after the EMS Design Protocol). Group 4 (36 facilities) included the facilities that completed at least the Baseline, EMS Design, and First Update Protocol, but not necessarily the Second Update Protocol. Comparisons between these two groups focus on the experience of facilities that dropped out of the study in the early or middle phase of the data collection process.

Group 5 (37 facilities) included all facilities that dropped out before completing the Second Update Protocol (that is, Group 3 plus those dropping out later). Finally, Group 6 (30 facilities) consists of those that completed all protocols through the Second Update. Comparisons between these two groups focus on the experience of all dropouts.

For each of these facilities, we recorded whether they had experienced any known significant events during the study period, such as a shutdown or downsizing, a purchase or other significant management change, or a catastrophic event, such as a flood or fire, and whether the facilities continued to implement their EMSs. A total of 38 such events were recorded. Figure XIV-2 shows the total numbers of facilities reporting each of these types of events.

FINDINGS

A total of 31 facilities experienced one or more of these 38 events, while 36 had experienced none. Forty-five of the 67 facilities also reported that they were continuing to develop and implement their EMSs, whether they continued to participate in the Pilot Program or not, whereas 21 were not. These data by themselves appear somewhat sobering as to the prospects for continuity of EMS commitments: nearly half the facilities experienced some major disruptive event, either physical or organizational, just during the five-year period of this study, and fully a third appeared to have dropped their commitment to the EMS itself as well as to the pilot study.

[139] For two of the 17 facilities in this group we were unable to obtain follow-up information, leaving 15 in the analysis.

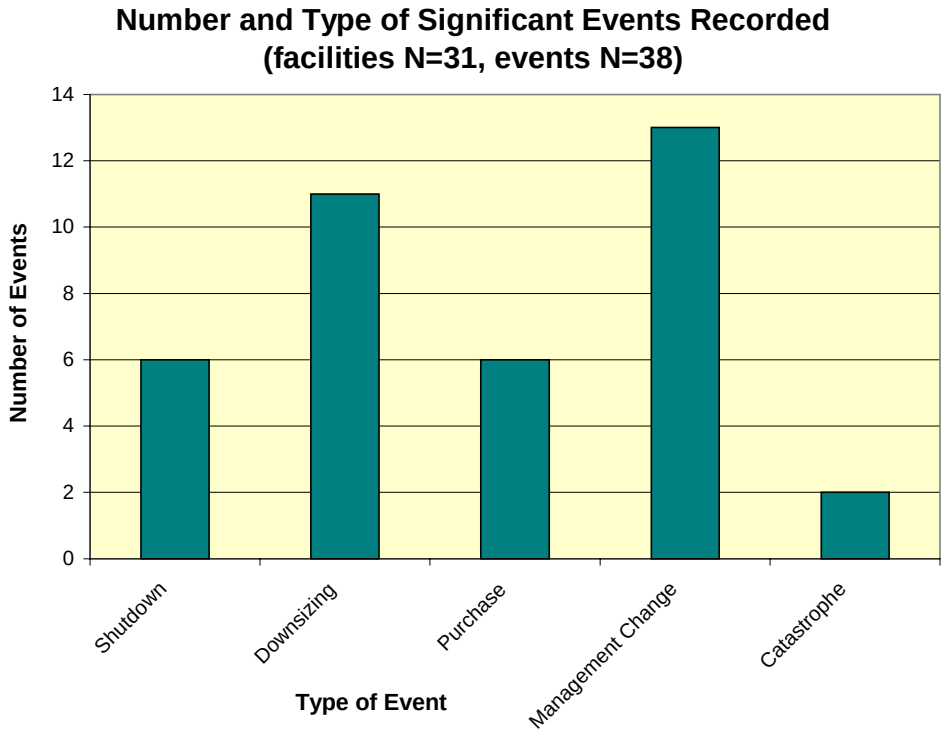


Figure XIV-2. Significant Events Recorded for Pilot Program Facilities.

Table XIV-1 shows the intergroup comparisons of events per facility and the strength of associations for each group between their experience of such events and their attrition rates.

TABLE XIV-1. SUMMARY AND CHARACTERISTICS OF GROUPS IN ATTRITION ANALYSIS

GROUP	1	2	3	4	5	6
N	15	52	31	36	37	30
Protocols Completed	Baseline, but not EMS Design	EMS Design	Baseline or EMS Design, but not First Update	First Update	Baseline, EMS Design, or First Update	Second Update
Events per Facility	0.33*	0.63*	0.61	0.53	0.70*	0.40*
Proportion Continuing EMS	0.40*	0.79*	0.58*	0.81*	0.59*	0.83*

* difference is significant, $p \leq 0.05$.

Comparing first Group 1 and Group 2, the average number of events in Group 2 (non-dropouts) was actually significantly greater than the average number in Group 1 (early dropouts): Group 1 averaged 0.33 events per facility, or 5 events across fifteen facilities, while Group 2 averaged 0.63 events per facility, or thirty-three events across fifty-two facilities. The proportion of Group 1 facilities continuing on with the EMS, however, was only 40 percent (6

of 15 facilities), while nearly 80 percent (41 of 52) facilities in Group 2 did so. These differences were statistically significant ($p \leq 0.05$). In short, even though relatively more significant events occurred in the sample of facilities that remained in the study beyond completion of the Baseline Protocol, their rate of continuation of the EMS was nearly twice as great as that of facilities that dropped out of the study after the Baseline Protocol. It is perhaps likely that early dropouts from the study dropped out mainly because they were dropping their interest in the EMS itself rather than because of disruptive events.

The same comparisons between Groups 3 and 4 show greater similarity in average number of events per facility (twice as many events per facility for Group 3 dropouts as for Group 1, though not statistically significant from Group 4). They also show nearly half again as many study dropouts continuing with their EMSs as Group 1 (58 percent versus 40 percent), and again, statistically significant differences in rates of continuation of the EMS between Groups 3 and 4 (58 percent of study dropouts, versus 81 percent of those continuing through the First Update). Facilities that continued on into the middle phase of the study, in short, were more likely than early dropouts to have experienced similar levels of disruptive events as compared with continuing participants, and were also significantly more likely than early dropouts to be continuing implementation of their EMS.

Finally, Groups 5 and 6 showed results similar to Groups 3 and 4 but with greater statistical significance. The average number of events in Group 5 was 0.70 (26 events across 37 facilities), a sizeable increase over earlier dropout groups as well as a significantly greater number than the continuing facilities in Group 6 (.40, or 12 events across 30 facilities). The proportion of Group 5 facilities continuing on with the EMS was 59 percent (22 of 37 facilities), versus 83 percent (25 of 30 facilities) in Group 6. These data show that significantly greater numbers of disruptive events occurred in the group that dropped out before completion of the Second Update Protocol, and that the rate of continuation of the EMS also was significantly greater in the group that completed the Second Update Protocol than for those that did not. Note also however that even among those facilities that completed all four protocols over the five years of the project, for one or another reason some 17 percent appeared not to be continuing their EMSs.

We explored the reasons why 22 facilities appeared no longer to be working on their environmental management systems. The few explanations given cited varied reasons – cultural conflicts within the organization, a fire, other events – but the most frequent explanation was a lack of resources, especially personnel.

We also investigated reasons why facilities dropped out of the Pilot Program, even if they continued to pursue the EMS. Again, lack of resources dominated the findings. In many cases, the program requirements to collect and provide data were seen as a bigger commitment than the facilities wanted to make. A number of facilities lost customers or contracts and re-evaluated their priorities, or they lost key personnel due to retirement, maternity leave, or reassignment. Two facilities had serious problems with compliance during the study, and this adversely affected their participation in their state pilot programs and also in our study.

As was shown in Figure XIV-2, six facilities shut down entirely during the period of the study, and another six were purchased. Five of the six facilities that were purchased did report that they were continuing to develop and implement their environmental management systems. In addition to continuing their EMSs, many of the pilot facilities also have continued on with

additional government-sponsored voluntary initiatives beyond the Pilot Program, for instance as participants in EPA's Performance Track and in other state partnerships.

INTERPRETATION

It appears that the frequency of events such as shutdowns, layoffs, buyouts, significant changes in management, and other catastrophic events such as fires could perhaps explain the loss of facilities from our study during the later phases, but probably not in the earlier phases of the study. Significant differences between the groups identified in this analysis were observed, and the direction of the differences in the comparisons reported in Table 14-1 suggests that such events could be an explanation for facilities dropping out as the study progressed.

The interviews we conducted with the state Pilot Program managers, and our own records from the data collection process, suggest also that limitations on and loss of resources may explain much of the attrition that we experienced. It is difficult to distinguish how much of the burden experienced by facilities that dropped out is associated with completing the protocols for the National Database relative to the burden of the expectations associated with participation in the state Pilot Programs. It appears that several facilities did drop out because of the data collection requirement, but many more appear to have dropped out due to loss of customers or contracts, or loss of key personnel.

In spite of the attrition that we experienced in our study, the evidence for continuation of the EMSs by facilities during the study period is impressive. Forty percent of the facilities that dropped out after completing only the first protocol appeared nonetheless to be continuing their EMSs, and more than half the facilities that dropped out later in the study also continued their EMS. When we compared the distribution in the number of events recorded for the 47 facilities that continued the EMS to distribution in the number of events for the 20 facilities that had stopped working on the EMS, the two distributions are nearly identical (Figure XIV-3). This result suggests that while a high rate of adverse events and loss of resources may explain the rate of attrition observed in our sample during our study, such events do not distinguish the facilities that continued their EMSs from the group that did not do so.

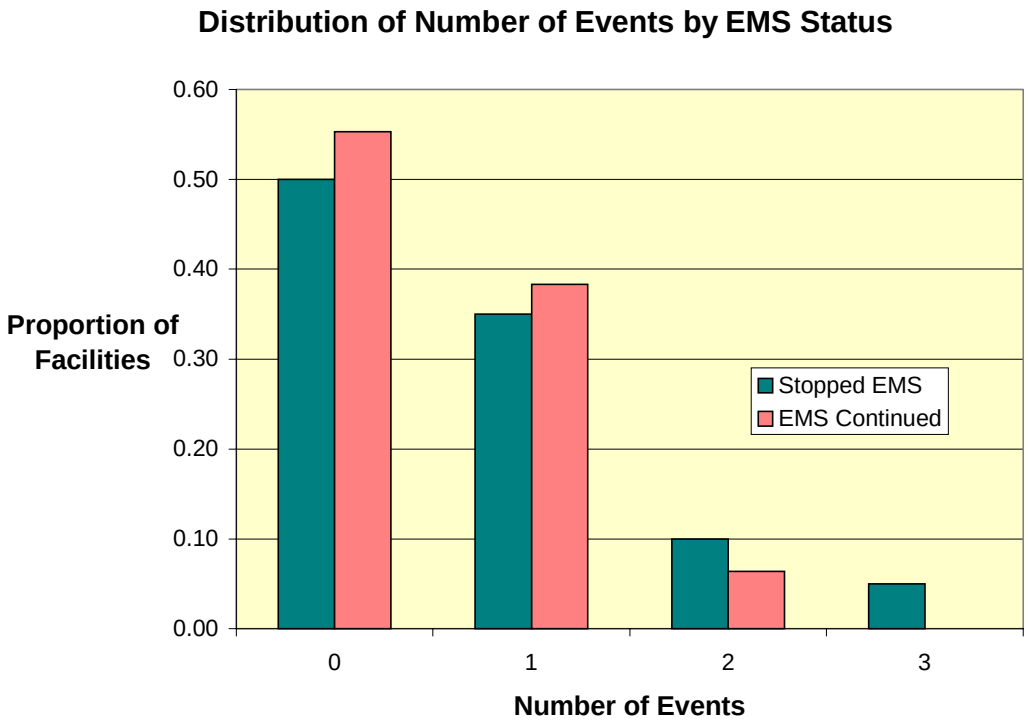


Figure 14-3. Comparison of Distribution of Number of Events with EMS

CONCLUSIONS

Our investigation of some of the characteristics of facilities that might be associated with the observed rate of attrition yielded a pattern that could be linked to several types of events and also to diminished resources during the study period. We observed an association between events such as shutdowns, buyouts, or layoffs and the loss of facilities from our study over time, but we did not see a strong relationship between such events and discontinuation of the EMS.

In fact, there was a high rate of continuation of the EMS, even among facilities that were no longer participating in the state pilot program or providing data to the National Database. It appears that many of the facilities that dropped out of the pilot program and the National Database study did so because of a lack of resources, often directly expressed as a loss or shortage of personnel. Several of the pilot programs did provide technical assistance and grants to facilities as incentives for participation, and this appears to have helped retain facilities in the study.

The support of the pilot program managers was invaluable as a source of motivation, encouragement, and technical assistance to many participating facilities during the entire data collection process. Indeed, the investigation reported in this chapter has focused on the pilot program facilities in response to that support: it would have been very difficult to follow up

with the public-sector and other facilities outside the state Pilot Programs to the same depth that we have been able to achieve with the pilot-program facilities.

Because of the small numbers of facilities studied, it is difficult to infer whether these patterns will hold in a larger population of facilities developing EMSs. Factors in addition to those we were able to identify and report could potentially be affecting continued participation in the study and the state pilot programs, as well as commitment to the EMS itself. Further research into the relationship between these outcomes and other facility characteristics could perhaps be useful.

A larger question for future research is not merely continuity versus attrition in commitment to the EMS per se (let alone to this study, or to the state Pilot Programs), but the meaning and results of "continual improvement" in facilities' EMSs over time, and the relationships of these outcomes to additional facility characteristics such as size and ownership status as well as disruptive events such as layoffs and buyouts. Do facilities' objectives and targets become more and more ambitious over time, moving from short-term incremental improvements toward more strategic transformations in environmental performance, or do they become more and more marginal as the "low-hanging fruit" – the easy, short-term, high-benefit improvements – are picked off? Does the EMS process as a whole retain its vitality and organization-wide commitment over time, or does it become routinized and delegated to the EHS staff after the initial enthusiasm of EMS introduction passes and its champions are promoted or transferred? The answers to such questions are important to public policy decisions that dependent on confidence in the facilities' continued commitment to EMSs over time, such as those that confer public recognition or regulatory benefits on facilities for their adoption of an EMS. However, they require revisiting facilities' commitments over a time period longer than the scope of this study.

The investigation reported in this chapter has provided some evidence that attrition from the study is likely to be due to resource constraints, possibly associated with major disruptive changes in the organizations we have examined. However, within the time period of this study such changes do not appear to have had a strong detrimental impact on the commitment of these organizations to continue to develop and implement their environmental management systems.

Chapter 15. Further Research Needs

The NDEMS pilot study has provided useful findings on the performance and compliance impacts of facility-level EMSs, on facilities' motivations and other factors associated with their introduction of EMSs, on the range of variation among facility-level EMSs themselves, on costs and benefits of EMS introduction, and on special considerations involved in EMS introduction by government facilities.

No one study can answer all important questions, however, and there are many important questions about EMSs that are not yet answered by this study. In this chapter we identify some of the additional questions about EMSs that deserve investigation, both for public policy decision-making and for EMS adopters themselves.

THE UNIVERSE OF FACILITIES

First, ***how does the performance of the EMS pilot facilities compare with the performance of the full universe of facilities that introduce EMSs, and particularly with those that are coerced or that start with more serious deficiencies*** in environmental performance and regulatory compliance?

It is likely that NDEMS' pilot facilities, because of its state partners' environmental compliance requirements for participation, had compliance records that were better than average. These facilities and their parent organizations also were likely to have greater internal capacities than non-participating enterprises, which suggests that the availability of external resources may be even more influential in facilities not represented in the NDEMS sample.

Future research should study how NDEMS facilities and their parent organizations differ from facilities that do not adopt an EMS, and whether they differ from facilities that adopt an EMS outside a voluntary environmental program, in order to understand the relationship that both EMSs themselves and government-sponsored voluntary initiatives have for organizations' internal capabilities.

In particular, further research should examine whether any facilities that start with serious deficiencies have used an EMS to achieve greater improvements than the NDEMS pilot facilities, and what success factors were associated with this achievement. Facilities that start with serious deficiencies could plausibly use an EMS to achieve far greater improvements than the NDEMS pilot facilities, simply because they would have so much greater potential for improvement to begin with. On the other hand, the deficiencies of such facilities might themselves reflect more deep-seated resistance or disincentives to improvements than could be overcome by an EMS alone.

What can an EMS accomplish in facilities not influenced by the "spotlight effect" of government-sponsored voluntary partnerships? In facilities that introduced an EMS because they were coerced to do so, such as by corporate headquarters or by a major business

customer? In facilities that had major deficiencies to remedy? Would such facilities use an EMS simply as a paper credential (or worse, as a cynical attempt to "greenwash" their poor performance)? Or might it provide an effective tool for "turnaround management" of sloppy environmental practices (and perhaps, inefficient management practices more generally)?

More generally, the data for the NDEMS facilities should be compared with data for larger groups of facilities in the same sectors, and also for facilities in other countries, to identify national and cultural differences in the uses of these procedures. It would also be useful to probe more systematically the relationships between what the EMS adopters thought they were getting into substantively when they adopted these systems, and the actual outcomes. The NDEMS pilot results suggest that there were substantial differences among facilities' expectations, and the range of their impressions about what EMSs would entail was markedly broader than the assumptions typically found in the business literature advocating such innovations.

Additional studies also would be worthwhile on the range of adaptations of EMSs to diverse sectors and circumstances, leading perhaps to development of replicable sector-specific EMS templates for particular sectors and facility types. Some of these are already occurring –for wastewater treatment facilities, screen printers, and some kinds of agricultural operations, for instance – but others might also be useful.

To the extent possible, therefore, future research should extend the NDEMS analysis to facilities that are not involved in voluntary environmental initiatives or other sorts of cooperative partnerships with federal and state environmental agencies. In particular, it should target facilities (and perhaps entire sectors) that have had histories of significant problems in environmental performance and compliance and used EMSs or other initiatives to achieve significant improvements. Some such facilities, for instance, have negotiated with EPA and a few state environmental agencies to include EMSs as "supplemental environmental projects" (SEPs) to be carried out as a condition of enforcement settlement agreements: do these then contribute to significant improvements in subsequent environmental performance and compliance?

CONTINUAL IMPROVEMENT

Second, ***what will the performance of EMS adopter facilities be beyond the initial period after EMS introduction?*** "Continual improvement" is one of the mandated commitments of the ISO 14001 international voluntary standard for EMSs, and it is a primary argument for the value of an EMS. The value of an EMS, advocates argue, and a key reason why it deserves commendation by environmental regulatory agencies, is that it promotes continual improvement in environmental management and not merely one-time changes to achieve compliance with environmental standards.

In particular, the objectives and targets actually set and achieved by each facility will be among the most important subjects for future examination, both by researchers and by government and the public, as an indicator of EMS success. The present study design did not allow us to categorize the relative difficulty/robustness of the various targets and objectives for which environmental performance indicators were reported, nor to identify to what extent these represented "stretch goals" as opposed to easy incremental improvements.

Continual improvement is an admirable ideal, but in practice it may not be easy to sustain. Some facilities may indeed use a system such as the EMS to drive their environmental performance to more and more ambitious levels – from compliance improvement to pollution prevention, eco-efficiency, and ultimately environmental and social sustainability – and to more and more fundamental rather than merely incremental improvements. Others may at least maintain the performance benefits of a formalized management system. Still others, however, may settle for a gradual attenuation of their improvement once they have "harvested the low-hanging fruit," the most immediately and significantly cost-effective changes in practices and processes. Still others may experience attrition from their commitments to the EMS process and objectives, as a consequence of shifting priorities, market setbacks, changes in ownership or management, or other factors.

Another important area for further research, therefore, is to investigate the fate of facilities' commitments to continual improvement of their EMSs over multi-year time periods, and to determine what factors are associated with continued or even increased commitment over time or with bureaucratization or even erosion of it.

It should also soon become possible to examine environmental performance changes of larger numbers of EMS-adopting and ISO-certified facilities as reflected in data collected by federal and state regulatory programs. These sorts of studies have been limited so far by the relatively small numbers of ISO-certified facilities as well as by gaps and time lags in the posting of facility-specific EPA and state data on environmental performance and compliance. Truly definitive results may also have to await significant improvements in some of these data sets themselves, but larger statistical studies of EMS adopters may soon become at least relatively more reliable, subject to caveats about the underlying limitations of these data sets.

An important related question is, ***what are the benefits and costs of EMS maintenance over time, and for what kinds of facilities?***

Additional research would be useful on the benefits and costs over time for EMS adopter facilities. The NDEMS pilot results suggest that the costs of EMS introduction were primarily concentrated in the first (design) year; that subsequent costs were relatively modest; and that benefits might continue over multiple subsequent years, rather than being limited to one-time "low-hanging fruit." Further research should investigate how the benefits and costs of EMSs play out over multi-year time frames, and in different kinds of organizations. Does an EMS have greater continuing net benefits, for instance, in facilities with high environmental costs and risks? With high employment and high personnel turnover (requiring constant training of new employees in environmental management practices)? With EMS more fully integrated into other management systems? In what kinds of facilities are EMSs most cost-effective, both in business value and in environmental performance improvement?

PUBLIC REPORTING AND STAKEHOLDER PARTICIPATION

Third, ***do public reporting and broad stakeholder participation produce better environmental performance results?***

The NDEMS pilot study considered the influence of stakeholder participation on EMS outcomes, and produced some useful findings with respect to stakeholders internal to the

facility (cross-functional teams and non-management employees, for instance). It was able to suggest only limited findings concerning the effect of involving external stakeholders (community groups, neighbors, local governments), however, since such stakeholders were involved in such a small fraction of the pilot facilities' EMS processes, and even then in some cases only because of state mandates. Further and more systematic study of this topic would be useful.

This question also implies a broader and more fundamental research topic: ***do facilities seeking external legitimacy for their EMS achieve better, worse, or similar results to those seeking only internal benefits such as increased eco-efficiency?*** Further research would be useful on the relationships between environmental and economic performance outcomes, on the one hand, and transparency and public reporting of fuller and consistent information on environmental and social performance indicators.

EFFECTIVENESS OF GOVERNMENT EMS INCENTIVES

Fourth, ***how will government incentives for EMS adoption and use – public recognition and regulatory flexibility, for instance, as well as technical assistance – affect environmental performance and compliance over the longer term?***

As research on EMSs continues, it will be important to understand how external resources affect facilities' environmental management capabilities and contribute to achieving policy goals. Prior studies of the impact of internal resources on businesses' behavior – the "resource-based viewpoint" (RBV) – have generally focused on how organizational resources shape these capabilities. Excluded from the discussion, however, is whether external resources also play a role, and more importantly, whether they result in the same outcomes. That is, do facilities that rely heavily on external resources develop EMSs that are as rigorous as the EMSs developed by facilities that did so entirely on their own?

Also, while consultants or government assistance may be used in the short-run to develop an EMS, are facilities that rely on these external resources able to continually improve their EMS over time without having to rely repeatedly on external support? Or do these external sources of support provide the necessary fodder for facilities to develop their basic competencies, while concurrently fueling the competencies needed to sustain advanced forms of environmental management such as an EMS?

Incentives for EMS adoption are now being introduced by an increasing number of states as well as EPA, on the presumption that EMS introduction will improve outcomes. Given that such incentive programs are not cost-free themselves, it will be important to ascertain the extent to which such incentives do in fact contribute to better performance and compliance, as opposed to merely rewarding facilities that were achieving superior performance already or would have done so in any case. Previous RBV literature suggests that sustaining an EMS over time may be difficult without these prior competencies in place. As such, government support programs may be more successful at encouraging organizations to develop the basic environmental management and management system capabilities, which serve as a stepping-stone for more advanced forms of environmental management that include EMSs.

IMPLEMENTATION ISSUES

Fifth, ***how do successful EMS adopters overcome implementation issues, and what models do their experiences offer for success by subsequent adopters?***

Successful EMS implementation requires overcoming numerous behavioral and organizational barriers as well as leadership and changes in operating procedures. The NDEMS pilot study has emphasized the characteristics and motivations of EMS adopters and the performance outcomes associated with EMS adoptions. With the exception of the case studies in Chapter 9, however, it did not address many of the detailed implementation issues that adopters had to deal with, and the consequences of their solutions to these issues. Some implementation behaviors were inferred from their attributes (for instance, leaders who supported the changes must have exerted leadership in their behalf). While useful, however, this approach has not addressed the many detailed fixes, techniques, and adjustments that were used to overcome internal resistance or to energize important program elements. This sort of information would assist future adopters in increasing the chances for successful implementation.

FACILITY-LEVEL VERSUS CORPORATE ENVIRONMENTAL MANAGEMENT

Sixth, ***how do facility-level EMS decisions interact with decisions made at the level of a larger corporate or government organization?***

The NDEMS pilot study focused on facility-level decisions. While EMS adoption occurs at the facility level, however, many facilities' decisions about their environmental management strategies are made at the corporate level. Evidence of this corporate-level influence was noted in preceding chapters: 75 percent of the publicly traded facilities adopted their EMSs because of corporate mandates, and 15 percent more did so because they were encouraged by their parent company. Conversely, EMSs for government facilities often were limited to individual facilities or operations, and did not address other environmental aspects and impacts of the same government jurisdiction. Thus, a key question for future research on EMSs is what factors influence parent organizations to mandate or encourage EMS adoption in their facilities, and how they might differ from facility-level adoption decisions.

Other important decisions affecting environmental outcomes also are made at the corporate level (or for government facilities, at the level of the overall governing body) rather than the individual facility, and thus could only be addressed in a corporate-level EMS. Common examples include strategic business decisions and reorganizations affecting corporate-wide environmental management, decisions about product design and materials, environmental and economic expectations of subsidiaries, and resources and templates for EMS development.[140]

A key question for future research, therefore, is what factors influence key decisions affecting environmental management and performance at the level of overall corporate and governing-body decision-making, and how the aspects, impacts, judgments of significance, and potential

[140] One particularly strong example is the Canon Corporation, based in Japan, which imposes a "zero waste" objective on all its facilities worldwide.

objectives and targets of parent organizations might differ from those available at the facility level.

One particularly timely topic for further research is the impact of corporate supply-chain mandates for EMS adoption on the environmental performance of affected firms. Several of the major automotive manufacturers, and some major business customers in other sectors, have mandated EMS adoption (and in some cases, ISO 14001 third-party auditing and certification) by their suppliers as well as their own facilities. Will they enforce these mandates? If so, will they look only at the fact of certification or examine the actual environmental performance results as well? Will suppliers implementing EMSs because of corporate or customer mandates improve their performance as much as those implementing them on a more purely voluntarily basis, or simply "go through the motions" of obtaining paper certifications?

EMSS FOR GOVERNMENT FACILITIES

Seventh, ***how can EMSs be used most effectively to improve the performance and compliance of government facilities?***

EMSs originally were developed as an instrument of private-sector business management, shaped by market incentives, capabilities and resources that are often absent for government facilities. Initial results suggest that so far, they also have been most effective in that business context.

Government facilities, however, generate many of the same environmental impacts as business facilities: motor pools and maintenance shops, for instance, as well as use of pesticides and hazardous chemicals and inefficient uses of water and energy. Many government facilities also are responsible for environmental management as a core mission, not just incidental to manufacturing or other market objectives: management of public lands, waters, species, and ecosystems, provision of urban water supplies and wastewater and waste management services, and regulation of pollution or landscape disturbances. Our findings also suggest that government facilities often start with less capabilities and resources for introducing an EMS and improving their environmental performance, and at higher cost to taxpayers.

Further research is needed on how to make EMSs most effective for government facilities, on the benefits and costs of EMSs to government facilities, on integrating EMS development into broader initiatives for improving management of government facilities and operations, and on environmental management capacity-building for government facilities and operations. Such research might also include the design of model EMSs for a number of key types of government agencies and public enterprises, taking into account relevant differences in their missions and capabilities from private businesses as well as the most cost-effective objectives and targets for their consideration; and the refinement of government EMS assistance programs to contribute most effectively both to better environmental management and to better management more generally at government facilities.

TRANSNATIONAL AND CROSS-CULTURAL COMPARISONS

Eighth, ***how do U.S. facilities' uses of EMSs compare with those in other countries?***

The introduction of EMSs is a global phenomenon, and the ISO 14001 model is an international voluntary standard for such systems. Far more facilities so far have been certified to this standard in other countries than in the United States, including many that are suppliers, competitors, customers, or corporate sister facilities to U.S. businesses.

What can be learned from their experiences? Are they introducing EMSs for the same reasons? Achieving similar results, or better or worse? Are they finding competitive advantages in EMSs that U.S. facilities should also recognize and seek? These questions are important to U.S. public policymakers as well as to businesses, since they affect the competitive environment in which U.S. businesses themselves introduce and implement the commitments of an EMS.

DO THIRD-PARTY AUDITING AND CERTIFICATION PRODUCE BETTER RESULTS?

Ninth, ***do externally audited and certified facilities demonstrate superior environmental performance than non-certified facilities?*** The NDEMS pilot study did not find evidence to confirm this result, but its sample was small, its time span included only the initial years of facility certification, and it did not include specific questions on the perceived benefits of regular third-party auditing. More systematic investigation over a longer period might perhaps show such an effect: for instance, regular external surveillance audits might create greater ongoing incentives for better data management in anticipation of regular reviews, for performance improvements to demonstrate continual improvement, and even simply for more accurate and trustworthy reporting by such facilities than by similar non-audited facilities.

A related question that is best approached internationally is, ***do facilities certifying to the European Union's Eco-Management and Accounting Scheme (EMAS) outperform facilities certifying to ISO 14001, and do facilities certifying to either of these voluntary standards outperform other facilities in their sectors?*** One recent British study suggests that they do (Dahlström and Skea, 2002), but this study was limited to administrative and procedural measures of performance; additional studies using actual environmental performance measures would be useful, to determine both whether and if so, why this is the case. In particular, further research would be valuable on the effects over time of third-party surveillance auditing and recertification, and whether facilities that continue such third-party oversight achieve better performance results and more enduring processes of continual improvement than those that do not. It is possible that due to the added rigor of the certification or auditing, the reported results from such firms also are more accurate and trustworthy.

A related question for facilities using the ISO 14001 model is, ***do facilities using the ISO 14001 EMS process also incorporate the other elements of the ISO 14000 guidance series*** (e.g. environmental performance indicators, life-cycle analysis, eco-labeling), and do those

facilities show better performance outcomes than those that do not? The ISO 14000 series was designed to provide a coherent and systematic guidance package for environmental management, not merely a single certifiable process standard; it would be useful to know whether it is in fact being used in that way, and whether those that do so achieve better results.

MULTI-FACILITY COORDINATION OF EMSS

One concern about many EMSs to date is that the selection of objectives and targets is entirely an internal process: the objectives and targets chosen are likely to reflect only the priorities and projects of managers within the facility, which may or may not match the most important environmental problems and priorities of the communities and ecosystems in which the facility is located.

As EMSs become more widely adopted, a final research question worth exploring is, ***can groups of facilities in the same community or ecosystem achieve more significant results by coordinating their EMS objectives and targets to improve the environmental outcomes for particular shared impacts***, such as smog reduction or improvement of water quality in a shared lake or river? Such coordination might be brokered by government, or by a local business association or civic group or ad hoc organization, but if successful such experiments might make EMSs far more useful instruments for achieving important environmental policy goals. It is a worthwhile area for innovative case studies and experimental research.

Chapter 16. Conclusions

The National Database on Environmental Management was designed as a pilot study to collect facility-level data, using longitudinal comparative-case analysis in real time, to examine the performance of facilities before, during, and after EMS implementation. The primary purpose of this study was to answer the question,

- What effects does the implementation of an EMS have on a facility's environmental performance, regulatory compliance, and economic performance?

The study also shed light on important related questions, including:

- What costs and benefits do facilities experience as a result of introducing (and where applicable, certifying) an EMS, and how do these vary with their characteristics and motivations?
- Do technical assistance and other incentives from governments make a difference? If so, to what kinds of organizations?
- What factors motivate organizations to introduce and certify EMSs, and what differences in facility characteristics and motivation are associated with these decisions?
- To what extent are EMSs themselves similar or variable – in their content, their priorities, and their development processes – and is variability itself an important finding?
- Who is involved in developing and implementing an EMS, and what difference does such participation make to EMS outcomes?
- What difference, if any, does third-party auditing and registration make?
- Why have even some non-market organizations, such as municipalities, state agencies, and federal facilities, decided to adopt such systems, and what have they gained from it?
- And finally, how do organizations' commitment to their EMSs evolve over time?

The NDEMS study tracked the EMS development process and changes in facility-level environmental performance, compliance, and economic performance for a five-year period including a three-year pre-EMS baseline period, the EMS design process, and two update periods at one-year intervals after introduction of the EMS. These facilities were drawn from 20 business sectors, and included both publicly traded, privately held, and government facilities such as military bases and wastewater treatment plants. They ranged from major manufacturers, electric utilities, and branch plants of large multinational corporations to small independent businesses such as electroplaters and auto parts suppliers. Approximately two-thirds of them were registered or intended to seek registration to the ISO 14001 international voluntary standard for EMSs; the remainder were using the ISO 14001 framework as a guide to their own efforts but did not intend to seek ISO 14001 conformity registration.

Highlights of key findings include the following:

BASELINE CHARACTERISTICS AND PERFORMANCE

The NDEMS facilities included a broad sample of facilities drawn from approximately 20 business sectors and 17 states. They included both autonomous units and subsidiaries of larger organizations, representing publicly traded and privately held as well as government ownership, and ranged in employment from very large operations to small and medium-sized enterprises. About half either produced or marketed products internationally, or were subsidiaries of a larger organization that did so.

Pre-Existing Capabilities

Nearly three quarters of the facilities had had some form of non-environmental management system in place before adopting an EMS, and half had previously participated in some form of voluntary environmental initiative, though most had at most one or two years' experience with them. Most also had some prior experience with more limited forms of environmental management procedures, such as waste minimization planning, pollution prevention planning, or compliance auditing. Publicly traded facilities were most likely to have engaged in each of these prior initiatives, and to have a formal pollution prevention plan in place, as were facilities with more than 300 employees.

One suggestive finding from these baseline characteristics was that the 40 facilities that had introduced formal pollution prevention plans were more likely to have engaged in most types of pollution prevention activities than were those facilities that had no such plan. This finding suggests that formalized plans and procedures – which would include EMSs as well as pollution prevention plans – may have real and positive effects on promoting beneficial environmental management practices within organizations that introduce them.

More than three-quarters of the facilities (77%) reported at least one element of an ISO 14001 EMS already in place during the baseline period. Facilities with more than 300 employees, facilities owned by publicly traded firms, facilities that participated in other voluntary environmental management initiatives, facilities that utilized multiple environmental management techniques already, and facilities that had established formal pollution prevention plans were most likely to have introduced at least one feature of an EMS before or during their baseline period.

More than 85 percent of the facilities tracked at least one environmental performance indicator (EPI) during the baseline period. On average each of the facilities tracked three such indicators, most often waste generation and disposal (85 percent), air releases (54 percent) and natural resource use (52 percent). Nearly half reported significant changes in their EPIs during the baseline period, most often resulting from changes in operating practices, processes, and the product itself; far less often due to changes in raw materials or in inventory or spills control.

Compliance History

Over 90 percent of the facilities were subject to environmental regulatory mandates, and more than a third of them (36 percent) had at least minor regulatory violations during the baseline

period, with a total of 117 minor violations among them. Nearly half also reported non-compliance or potential non-compliance situations that could have led to violations (a total of 379 such situations). Six facilities also reported major or significant violations during their baseline period (23 total). The most frequent violations were violations of emissions or discharge limits or of monitoring requirements. Three-quarters of the facilities (76 percent) reported fewer than five minor violations; the median number reported was two. Ten facilities also had repeat violations, and nine reported monetary fines associated with their violations, with a median fine of $4,500. No significant differences in patterns of violations were found between facilities in different sectors or of different sizes, and facilities without prior management initiatives were no more likely than facilities with this baseline experience to have reported violations.

Inspections were the most common method for detecting violations, and more than three-quarters (76 percent) of the facilities with violations reported at least one violation discovered by regulators. Half the violations were discovered and corrected within a matter of days, but fully twenty percent went undiscovered for more than two months, a delay that could conceivably be reduced by an effective EMS. Unknown factors were most frequently cited as the cause of violations (30 percent), followed by deficiencies in operational procedures (23 percent) and lack of proper monitoring (16 percent); all these causes might be directly addressed by an EMS, as might the most frequently reported corrective actions (revisions to facility procedures, obtaining required measurements and documentation, and providing training to employees). Similar patterns were evident for non-compliances, which were most frequently discovered by formal facility audits (internal or external); these too are a specific element of an EMS.

MOTIVATIONS FOR ADOPTING AN EMS

What motivates facilities to introduce an EMS, and what role do government incentive programs, such as the EPA and state pilot programs – play in influencing them to do so? As discussed in Chapters 2 and 6, two distinct bodies of theory have emerged to explain why businesses might introduce new practices such as EMSs. One attributes such decisions to external influences, in particular regulatory pressures, market forces, and social pressures. The other (the "resource-based view," or RBV) attributes them to internal drivers: management capabilities (and in particular, highly developed learning processes that are not easily replicated by competitors) and resources. In reality, both types of drivers appear to operate simultaneously, with consequences that differ depending on such factors as ownership (publicly traded, privately held, government) and presence or absence of a larger parent organization.

External Drivers: Regulatory Pressures and Market Forces

Of the external drivers, all three types of facilities reported that regulatory pressures had the greatest influence on their decisions to adopt an EMS: 85 to 100 percent of them reported that the possibility of compliance improvement had either a high or moderate influence on their EMS adoption decisions. However, the influence of potential regulatory benefits motivated government facilities' EMS adoption decisions more than they did those of publicly traded or privately owned facilities. It is unclear why these differences exist, but they may be due to the

slightly higher number of regulatory non-compliances and potential non-compliances that government facilities experienced prior to participation (75 percent).

Perhaps the most important finding related to regulatory drivers was the role that government assistance programs played in influencing privately owned and government facilities' participation decisions. These programs influenced 55 percent of privately held businesses and 88 percent of government pilots. In contrast, only 11 percent of facilities owned by publicly traded corporations were motivated by receiving such aid.

In general, market pressures had only a moderate influence on all facility-level decisions, and there were no statistically significant differences between publicly traded and privately owned facilities. Market drivers were less relevant, however, to government facilities. Additionally, publicly traded and privately owned facilities saw in EMSs the possibility of increasing their revenues (64 percent and 48 percent respectively) and reducing costs (73 percent and 90 percent reported them as high or medium influences), which suggest that these facility managers were considering an EMS as a tool to increase organizational efficiency. In contrast, government facilities only considered half of the efficiency argument: they reported that while reducing costs was an important factor in their EMS adoption decisions, the possibility of increasing revenue was not.

Social drivers were the least influential of the external drivers, for all three types of facilities. It is worth noting, however, that when designing the EMS Pilot Program, regulators had hoped that facilities might be influenced to adopt an EMS if they were offered benefits in the form of enhanced publicity (that is, favorable press coverage, pollution prevention awards, and highly advertised annual conferences). It appears that increased public-relations opportunities did moderately influence all pilot participants' EMS adoption decisions, although less so for publicly traded organizations.

Internal Drivers: Management Capabilities and Resources

With respect to internal drivers (management capabilities and resources), significant differences among the three facility types were evident. For instance, a majority of the publicly traded (67 percent) and privately held owned facilities (50 percent) had ISO 9000 capabilities in place prior to EMS adoption, and because of this preexisting capability, EMS implementation likely demanded fewer internal resources and was more easily integrated into the facilities' management practices. In contrast, none of the government facilities had in place a certified quality management system (QMS) prior to EMS adoption. Similarly, most of the publicly traded and privately held facilities had engaged in pollution prevention activities prior to EMS adoption (93 and 95 percent, respectively) while only 62 percent of government facilities had done so.

Finally, publicly traded facilities appeared to have the greatest access to internal slack resources with which to develop capabilities such as an EMS, and government facilities the least. Almost all of the publicly traded enterprises (96 percent) belonged to larger organizations, while 65 percent of privately owned and 62 percent of the government facilities did so. Of those facilities that were units of larger organizations, moreover, publicly traded facilities were more likely than privately owned facilities to receive financial or technical support from them, and government facilities were less likely than either type of for-profit organizations to receive such support. Similarly, publicly traded facilities were more likely

than either privately held or government facilities to have their parent organization provide them with an EMS template that offered them guidance during EMS implementation.

Taken together, these results show that publicly traded facilities had greater overall access to resources and proficiencies, and specifically that they had greater internal capabilities that supported EMS introduction, than did privately owned facilities and government facilities. Government facilities had the lowest internal capabilities to support their EMS initiatives.

ENVIRONMENTAL PERFORMANCE CHANGES

The core objective of this study was to provide answers to the question, what effects does the implementation of an EMS have on a facility's environmental performance, regulatory compliance, and economic performance? Thirty-seven facilities provided update data for baseline environmental performance indicators (EPIs) that the facility had reported during their baseline period and which the facilities continued to monitor, as well as data for new EPIs that were developed after the baseline period.[141] The data covered a period of approximately 2.5 years, on average, after reporting their baseline data; this period included the period during which the EMS was being developed and introduced. The coding and analysis were also replicated using only those EPIs that were plausibly related to the facility's EMS objectives and targets.

Environmental Performance Indicators

More than 80 percent of the facilities that reported both baseline and update data tracked at least one environmental performance indicator, and most tracked one to five such indicators. Almost all of the update facilities (96 percent) tracked at least one indicator of waste generation and disposal from the baseline to the update period. More than half of these facilities monitored sustainability or recycling indicators (52 percent), natural resource use (52 percent), wastewater generation and air releases (63 percent for each) throughout the study period. However, more than half the facilities (56 percent) tracked fewer than 10 EPIs, and two facilities accounted for more than one-third of all reported EPIs (112 indicators).

Nearly half of the facilities (48 percent) had performance outcomes that included both improvement and deterioration, as well as unchanged performance. For more than half of the reporting facilities (56 percent), at least half of all indicators improved; and 63 percent reported improvements (and only 30 percent reported worsening) in indicators associated with their EMS objectives and targets. These observations suggest that environmental performance is more impressive for indicators that have been singled out for priority through the EMS process. However, a comparison of overall performance results revealed no statistically significant difference in performance outcomes between the O&T set and the full set of EPIs.

[141] These 37 facilities were statistically similar in most characteristics to the full sample of facilities that reported baseline data, including those that failed to report update data. The one exception was that facilities that reported during the update period were less likely to have experienced changes in regulatory status during their baseline period, though almost all of the update facilities (97 percent) had at least one regulatory requirement during the same period.

EMSs and Environmental Performance Change

The results suggest strongly that the introduction of an EMS does make an observable difference to a facility's environmental performance. More than two-thirds (68 percent) of the environmental performance indicators for which a change in performance was reported by the facilities showed improvement, and improved indicator performance was observed in at least half of facility indicators for a majority of these facilities (56 percent). While some deterioration in EPI performance may nonetheless occur after EMS adoption – 56 percent of these facilities had at least one performance outcome that was worse than expected – overall, only 18 percent of the EPIs exhibited worse performance outcomes, and only one facility reported worse performance outcomes for half or more of the indicators monitored.

ISO Registration and Environmental Performance Change

The majority of reporting facilities (59 percent) intended both to certify their facility EMS to ISO 14001 and to use a third party to audit their system. Four facilities intended to certify their EMS, but did not currently use or intend to use third party auditors; four others were currently audited by a third party but had no intention to certify; and the remaining three had no intention of either ISO 14001 certification or third party auditing. The mean performance score of the sixteen facilities that were certifying their EMS to ISO 14001 and utilizing third-party auditors was not statistically different from the others. These results do not provide support for the proposition that an externally audited, ISO-certified EMS is associated with greater improvements in environmental performance than uncertified facilities.[142]

Motivations and Environmental Performance Change

Findings reported in the previous research literature led us to expect that the relationship between an EMS and environmental performance might differ depending on the facility's motivations for adopting the EMS, such as the influences of external drivers (regulatory and social pressures and market forces) and internal drivers (management capabilities, resources).

Regulatory drivers were strongly associated with environmental performance outcomes whether or not they were reported as important influences. While there was no correlation between the self-reported importance of regulatory considerations on EMS adoption decisions examined and EIPI scores, the occurrence of regulatory violations or non-compliances at a facility was negatively associated: lower post-EMS performance scores were observed for facilities that reported at least one instance of a violation or non-compliance during their baseline period when compared to facilities without regulatory infractions.

Significantly higher aggregate scores for EPI improvement also were associated with the facility's perceptions that the prospects for marketing potential, competitive advantage, increased revenues, or support of other professionals were important influences on their EMS adoption decisions.

[142] It is possible, however, that the first update data were collected too soon to provide clear evidence one way or the other, since they were generally less than a year after introduction of the EMS and in many cases any intended certification had not yet occurred. Longer-term tracking of performance indicators would be necessary to develop definitive answers to this question.

Pre-Existing Capabilities and Performance Change

Higher performance scores also were strongly correlated with higher pre-existing levels of internal management capabilities, as measured by facility ownership (publicly traded, privately held, government). Publicly traded firms, with the strongest internal capabilities and greatest access to organizational resources, had higher EIPI scores than did privately held and government facilities with their more limited prior capabilities and resources. Different performance outcomes also were observed between facilities that had already developed internal capabilities specifically for EMS adoption (such as prior implementation of continual improvement and environmental management programs) and those that had not.

Compliance History and Performance Change

Finally, higher performance scores also were strongly associated with a record of prior compliance with regulatory requirements, whether or not the facility reported that regulatory considerations were important to EMS adoption decisions. Facilities that reported at least one instance of a violation or non-compliance during their baseline period scored lower on post-EMS environmental performance when compared to facilities without regulatory infractions.

COMPLIANCE CHANGES

Facilities also reported any instances of regulatory violations or non-compliances that occurred at the site, both in the three-year baseline period and in the initial update period following it (during and after EMS introduction).

Changes in Compliance Rates

During the baseline period, nearly half of the reporting facilities (15 of 33 facilities) reported at least one violation of regulatory requirements, comprising a total of 86 official notices of violation (NOVs) issued to these facilities. After EMS introduction, violations were reported by only six facilities. Statistically, data from this sample of facilities did not show that these changes represented a significant effect by EMSs on regulatory compliance. Introduction of an EMS also showed little change in the number and severity of fines levied for regulatory non-conformance. However, the substantial number of facilities eliminating violations after EMS implementation does provide some support for the proposition that introduction of an EMS at the facility improves regulatory performance There also was no evidence to suggest that EMS implementation might lead to worsening compliance.

What factors, if any, were associated with differences in compliance outcomes? ISO auditing and certification or intentions to pursue them made no observable difference. Of the external motivators, statistically significant ratings of adoption motivations were evident only for those factors that represented market forces: in each case, improved facilities had rated the influence of market considerations higher than did unimproved facilities. Improved facilities rated the influence of domestic customers, international customers, use of EMS as a marketing tool, pressure from shareholders or owners, and potential for competitive advantage higher in each instance than did unimproved facilities.

Compliance Rates and Ownership Status

The difference in ownership status between improved facilities and unimproved facilities was stark. More than two-thirds of the unimproved facilities were government installations. In contrast, all eleven of the improved facilities -- and only two of the four unimproved facilities -- were publicly traded or privately held.

These results are not surprising when one considers the ownership-related success factors discussed previously. Government facilities were consistently deficient in the internal resources that supported business facilities in their introduction of EMSs, and that also appeared to help facilities to improve overall environmental and regulatory performance. The high number of privately held facilities that improved their regulatory performance also suggests a stronger role for market-based influences, as these facilities' internal management capabilities, while stronger than those of government facilities, were not as strong as those of publicly traded facilities Further research might help to understand this relationship more clearly as it pertains to improved regulatory compliance outcomes.

While not conclusive, these results tend to support market-based explanations for facilities' improvement of their environmental performance. Facilities that did improve their regulatory compliance (e.g., eliminated NOVs) were primarily motivated to adopt their EMS either by external market forces or by internally-developed management capabilities.

COSTS OF EMS ADOPTION

What costs do facilities experience in introducing and certifying an EMS, and how do these costs vary – if at all – with characteristics of a facility such as its size and complexity, pre-existing management capabilities, access to resources, and other factors?

Cost Differentials by Ownership Status

First, organizations with stronger organizational capabilities prior to EMS adoption incurred lower EMS implementation costs, whereas organizations with fewer organizational capabilities incurred higher implementation costs. These findings have important implications for government policy makers who are encouraging the widespread adoption of EMSs, as some types of operations may need additional assistance in order to make implementation of an EMS a viable option. They also are consistent with and extend prior research regarding the resource-based view of the firm.

Compared to privately owned and government organizations, publicly traded facilities experienced lower total costs per employee to design and implement an EMS, and government facilities spent the most. Publicly traded facilities spent approximately $267 per employee, in contrast to privately held facilities and government entities, which spent an average of $531 and $1,441, respectively.

Labor was the most costly component of designing an EMS for all types of pilot facilities, accounting for more than half of the average total costs. Labor costs for government facilities were 2.6 times greater than privately owned companies' costs, and 4.1 times greater than those of publicly traded facilities. Interestingly, government facilities were similar to private companies in that they spent over half of their average total costs on staff time. However, the government facilities relied on consultants to a much greater degree, investing approximately

$499 per employee (36.3 percent of their average total cost), as compared to $37 per employee (7 percent) paid by privately owned enterprises. Publicly traded facilities relied even less on consultants, investing only 4.3% of their average total costs ($11 per employee) for their expertise and instead relying on in-house labor, which accounted for 77.2 percent of their EMS design costs.

Costs, Capabilities and Resources

While higher internal capabilities and greater access to resources were associated with lower facility expenditures on EMSs, what elements contributed to the differential availability of these resources and capabilities for EMS development in different types of organizations? Key elements included the previous introduction both of innovations in general management systems and of innovations in environmental management per se.

Almost all publicly traded facilities (90 percent), for instance, had instituted either ISO 9000 or other total quality management (TQM) systems prior to EMS development, whereas none of the government pilot facilities had adopted quality management programs prior to EMS development. More than three quarters of the publicly traded facilities (76 percent) also had adopted at least one other innovation in their management systems (such as just-in-time inventory or materials accounting) prior to EMS development, whereas none of the government facilities had done so. Privately held organizations had introduced such management capabilities at similar rates as publicly traded facilities, although development of these systems was less extensive than at publicly traded facilities.

Similarly, 48 percent of publicly traded and 44 percent of privately held facilities reported that they had already incorporated pollution prevention into their routine business planning, whereas none of the governmental facilities reported having done so. Fully 81 percent of publicly traded facilities also reported use of advanced environmental management techniques such as life-cycle analysis or risk assessment; only 25 percent of privately held facilities did so, however, and only 7 percent of government facilities.

These data confirm and flesh out the differences in internal capabilities associated with facility ownership status. Publicly traded facilities had developed higher levels of environmental management capabilities prior to EMS implementation than either privately held or government owned facilities, and government facilities had developed the least.

Access to Capabilities and Resources

Finally, there were striking differences among the three types of facilities in their access to EMS design resources from their parent organizations. All three types of facilities were asked whether or not they were part of a larger business or government organization, and whether their facility or its parent organization was publicly traded, privately owned, a municipality, or a federal facility. For government facilities, this relationship might be exemplified by a facility that was part of a larger municipal government or federal agency; it was assumed <u>not</u> to include capabilities and resources provided by the pilot programs themselves, since these were provided by other federal or state agencies (U.S. EPA, state environmental agencies) rather than by the government organizations of which the facilities were subsidiaries.

The parent organizations of publicly traded facilities (95 percent) were far more likely to provide some support to their facilities for EMS development than were those of either

privately owned or government facilities (95 percent, versus 27 and 20 percent respectively). Furthermore, only publicly traded parent organizations appeared to provide technical assistance to their facilities with regularity. More than two-thirds (68 percent) did so, as compared to just 27 percent of the parent organizations of privately held facilities and 20 percent of those of government facilities. All these differences were statistically significant.

Finally, more than two-thirds of the publicly traded parent organizations (68 percent) provided template EMSs to assist their subsidiary facilities. By contrast, none of the government facilities' parent organizations provided such templates, and they were nearly as rare at privately owned facilities (18 percent). All these differences too were statistically significant.

Differential Use of Consultants

The dearth of support by parent organizations of government facilities may in part explain the large expenditures of these facilities on consultant services. As noted above, government facilities relied on consultants to a much greater degree than did private-sector facilities, and spent more dollars per employee on them than either publicly traded or privately held facilities. Privately held facilities also were more likely than publicly traded facilities to have employed the services of a consultant during their EMS design period, although they spent statistically similar amounts on them as did publicly traded facilities (and far less than did government facilities).[143]

The need for this additional external expertise and support, on the part of both privately held and government facilities, was also evident in the importance they attributed to government-offered assistance in their EMS adoption decisions. Half of all facilities that rated the importance of this assistance "high" or "medium" in their adoption considerations were privately owned, and 83 percent of all government facilities gave it similar ratings. In contrast, 90 percent of all publicly traded facilities gave governmental assistance a rating of "low" impact on their adoption decisions, and none rated it "high." These differences were significant between all three organizational types, collectively and paired.

These results suggest a clear difference, consistent with our expectations, in the availability of resources to facilities from parent organizations. Facilities owned by publicly traded organizations received the greatest support from their parent companies, with nearly all receiving some support for EMS adoption from their corporate organizations. Conversely, external assistance in EMS design – such as consultant services or government assistance – was used far more frequently and viewed far more positively by facilities that received less support from parent organizations. Facilities operated by governmental organizations had the fewest available resources, with least encouragement for EMS adoption by the parent entity and few offers of technical assistance once the facility began development of the system. These facilities' expenditures on consultant services in designing the EMSs, and the perceived importance of assistance programs to them, further illustrate the inability of their parent organizations to provide resources for EMS development. Privately owned organizations also appeared unable to provide the same level of support for EMS implementation to their

[143] As was previously noted, a variety of incentives – including monetary grants – were offered to facilities participating in the NDEMS study. We observed that several privately held facilities that reported consultant use during EMS design did not report costs associated with these services. These facilities noted in their cost reports that these charges were offset by state grants.

facilities as publicly traded parent companies, and as a result their facilities were more likely to seek resources for EMS development from external sources such as consultants or governmental technical assistance programs.

BENEFITS OF EMS ADOPTION

Other than improved environmental performance and compliance, what benefits did facilities believe that they gained from EMS adoption? In both the EMS Design and Update Protocols, facilities were asked to identify any benefits, both quantified and unquantified, which they attributed to introduction of the EMS.

Perceived Benefits

A large majority of the NDEMS facilities (86 percent) reported benefits from either the design or implementation of their EMS. Together, these facilities described benefits in six broad categories: increased management efficiency, increased operational efficiency, reduced liability, regulatory benefits, improved community relations and improved customer/supplier relationships.

Patterns in the reported benefits suggest that in general, the EMS led to increases in the operational efficiency of the facility which were reported as reductions in inputs such as energy, water and materials or reductions in waste generation and disposal. More than three-quarters of the facilities for which benefits were observed identified benefits of this nature. Improvements in management efficiency also were commonly reported, particularly in association with increased employee involvement. Reductions in liability were reported as benefits in more than half of these facility reports (53 percent), and reductions in insurance costs, in long-term environmental liability, and in health and safety liability also were reported anecdotally. Finally, benefits related to improved relationships with regulators also were reported by a majority of the NDEMS facilities (53 percent). These facilities described improved compliance, improved regulator relationships, reduced violation fines and expedited permits as EMS benefits.

These results suggest that even though many economic benefits were not quantified, many of these facilities perceived benefits that in the long run might be subject to more quantitative estimation as facilities became more adapt at identifying and tracking changes to their operations and management practices.

Quantified Benefits

The benefits that facilities actually quantified were considerably more limited, and on balance the average quantified net benefits were negative, though not by large amounts in most cases. Monetary savings during the design period were infrequently observed, although two facilities (6 percent) reported approximately $350,000 in total savings during their design phase. Half of this total was reported by one facility as savings in waste disposal costs, while the remaining savings were unspecified.

A greater number of facilities reported monetary savings during the update period, but three quarters of the facilities (76 percent) did not identify any monetary savings during this period either. The average savings observed was $79,493. Of those facilities reporting savings during

the update, the highest was approximately $1,217,000, while the lowest was $24,000. One facility reported increased revenue attributed to implementation of its EMS: in this single instance the facility reported generating more than $40,000 in additional revenue due to its ability to reduce VOC emissions below permitted amounts and to sell these excess ATU (Air Toxics Units) on an emissions permit market. Of the quantifiable monetary benefits reported, average savings per facility from reduced materials use totaled approximately $45,077, which accounted for 57 percent of the average total benefits.

The primary kinds of quantifiable benefits identified by the facilities were cost savings rather than increased revenues. The majority of benefits were related to reductions in operational costs such as waste disposal and generation and materials use. There was ample evidence to support the assertion that EMS could help to reduce some of the costs associated with negative environmental impacts, which benefited both the facility and, through lower volumes of waste and material use, the environment. These results also support prior findings that suggested improved management efficiency as one real, though difficult to quantify, benefit of EMS implementation. Improved regulatory performance and reduced liability might also be potential sources of additional monetary savings, should facilities be able to specify and monitor these benefits.

The experience of one facility provides examples of the savings and revenue benefits that were quantified by the NDEMS pilots. This facility reported approximately $273,000 in savings from the reduced use of materials at the site by using more efficient chemical processes in the production of their primary product and by modifying the packaging of the final product. Monetary benefits reported in the "other" category, which averaged approximately $34,000 per facility, accounted for an additional 43 percent of the average total benefits. Of the savings that were characterized as "other," three categories were commonly noted: reduced waste disposal costs, reduced fines, and reduced water costs.

While the average reported benefits at these facilities – $90,320 for both design and update periods – appeared somewhat impressive, it is important to reiterate that this result was largely driven by the success of a relatively small number of the pilot facilities. Most facilities did not report quantitative monetary benefits of their EMS. On the whole, net benefits were negative over the combined design and implementation periods. Net benefits during the EMS design period averaged approximately ($81,000).

While the majority of NDEMS facilities (59 percent) reported no additional monetary costs during the update period, the average cost observed across all facilities was approximately $24,500. The majority of these costs were attributed to the acquisition or upgrading of equipment (62 percent). Net benefits during the update period averaged approximately $55,000, and benefits outpaced costs for seven of the eight facilities reporting monetary benefits during the update period.

In short, while the unquantified benefits that were reported offer some degree of optimism for the potential of an EMS to improve the economic performance of adopting facilities, more often than not the quantified costs reported by most of these facilities outweighed the quantified benefits they could document. If the additional unquantified benefits cannot be more fully substantiated in the future, commitment to the EMS may erode.

Benefits of EMS Registration

For facilities that chose to design their EMS to the ISO standard and to pursue a registered environmental management system, one might expect that net benefits would be different due to the additional costs of registration and auditing fees. Conversely, one might also expect that the additional scrutiny of outside observers might push the facility to design a system that was capable of extracting measurable economic benefits from the program. However, the results showed no statistical differences between the net benefits observed at facilities that were registering their EMS to the ISO standard ($40,200) and those without registration intentions ($40,020). Similarly, non-registering facilities were no less likely to have reported at least one quantifiable or unquantifiable benefit (14 of 19 facilities) than were registering facilities (16 of 18 facilities).

Benefits in Relation to Motivations

A question that runs throughout this report concerns the motivations of facilities to adopt EMSs. Few associations were observed between net benefits and facilities' adoption motivations. Interestingly, facilities that rated a desire to increase revenues higher as an influence on their adoption decision achieved more impressive net benefits than those that did not. This offers preliminary evidence that facilities expecting some economic benefit from EMS adoption realized such savings.

However, total benefits at those facilities motivated by revenue concerns were statistically the same as at those rating increased revenues less important in their decision making process. Costs of EMS design and implementation, however, were significantly lower at revenue-motivated facilities (averaging $58,705) than at non-revenue motivated facilities (averaging $112,409). These results seem to imply that instead of garnering greater benefits from their EMS, facilities that anticipated monetary benefits instead held the line on design and implementation costs. This result is consistent with the fact that nearly all observed benefits at these NDEMS facilities resulted from reduced costs rather than from increases in facility revenues. What these results appear to show is that motivations played a role in the benefits observed at these facilities.

This pattern is by no means complete, however. For instance, while more than half of the NDEMS facilities reported non-quantifiable benefits from improved regulatory relationships, facilities that considered the potential for improved regulatory compliance important to their adoption decision were no more likely to report benefits of this nature than were other facilities. These considerations are particularly relevant for policy makers as they attempt to balance benefits to the public good of environmental protection and improvement with the motivations and expectations of facility and organizational management.

SIMILARITIES AND DIFFERENCES AMONG EMSS

Adoption and registration of an EMS are voluntary actions, representing at least a desire to signal a commitment to good environmental management practices. The actual design and content of the EMS, however, are highly discretionary. What then does it signify that a facility has a formal EMS, or even that it has an EMS that is registered as conformant to ISO 14001? What should a government regulator or interested citizen infer from the existence or

registration of an EMS? Most of the NDEMS facilities had adopted the ISO 14001 model for their EMSs, and approximately two-thirds of them stated that they had obtained or intended to seek ISO 14001 registration. For all of them, the ISO standard provided a widely available benchmark for comparison of similarities and differences in current practice as to what an EMS contains and means.

Activities and Environmental Aspects

Overall, the facilities focused their EMSs predominantly on site-specific operations and production processes, and to a lesser degree on materials and energy use. With very few exceptions, they did not use the procedure to identify or improve environmental aspects of their products. The facilities' approaches to aspect identification also revealed great differences in levels of detail.

Impacts

Most facilities considered the impacts of their activities on waste generation, pollution, and natural resources. A majority considered impacts on regulatory compliance, and a surprisingly large fraction (nearly half) also included at least some impacts on health and safety.[144] However, less than a third specifically identified positive impacts for continued support and improvement. Large facilities and facilities intending to seek ISO 14001 registration paid attention to a wider range of impacts than did those that were not, and government facilities paid more attention to health and safety and to beneficial impacts than did publicly traded or privately held businesses.

Significance Determination

Significance meant very different things to different facilities. Nearly three-quarters used a formal scoring system to rank the significance of their impacts, but the factors they considered – environmental impact, regulatory compliance, cost, and others – differed considerably. One EMS may represent a facility that is so thorough in its analysis – or so relatively benign in its overall environmental effects – that it considers even oil-contaminated swabs to be significant environmental impacts, while another may be so focused on major industrial hazardous waste streams or air pollutant emissions – or simply on compliance for regulated impacts – that it has not even thought to identify such aspects as swabs, let alone designate them as significant. Two arguably "similar" facilities may have different EMS design processes and criteria that lead to quite different judgments of significance.

Objectives and Targets

Facilities set four distinct types of objectives and targets: performance-based, project-based, management-activity-based, and compliance-based. Small and independent facilities on average set more objectives and targets for improvement than did larger facilities and subsidiaries, but their objectives were less often quantified and more often oriented to intermediate outcomes (such as managerial tasks or compliance) than to specific

[144] Surprising inasmuch as the ISO 14001 EMS model did not formally include health and safety issues within the scope of its definition of environmental aspects and impacts.

environmental performance improvement outcomes. Large facilities and subsidiaries of larger organizations, however, set a higher proportion of their objectives and targets on actual environmental performance-improvement objectives and on specifically quantified targets for achieving those results. Very few facilities set objectives and targets related to improving the environmental performance of their products. Finally, all the target dates reported by the NDEMS facilities fell into one of three categories: already accomplished (a few cases), the current year, or "continuous" or "ongoing" (as for instance in maintaining compliance). None mentioned any objectives or targets for two or more years into the future.

Summary

In short, facilities have considerable discretion in how they design their EMSs to reflect their environmental goals and objectives and their management priorities and culture. These findings suggest that in practice they exercise this discretion to produce EMSs that differ quite significantly in their interpretations, approaches, and levels of detail, and in their judgments, priorities, and aggressiveness in pursuing environmental performance improvement.

These findings strongly suggest that the content of the EMS—the scope of activities, products and services considered, the impacts whose significance is identified or overlooked, the objectives and targets selected for improvement, and the organization's actual performance in achieving them—will probably prove to be far more important and informative to examine than the mere existence of an EMS or even the fact of ISO 14001 EMS registration.

A TYPOLOGY OF EMSS

Facility-level EMSs reflect the unique operating cultures, goals, and levels of experience of the organizations that design them. EMSs may be designed merely to enhance compliance, or in addition to promote pollution prevention or "eco-efficiency" in production processes and operations, or even to promote stewardship of materials, energy, and other environmental impacts and risks throughout the full life cycle of the facility's products ("product stewardship"). They may be designed by a small staff in the facility's environment, health and safety office, or by a broader and more cross-functional working group, or with input from a still larger and more heterogeneous range of employees and even outside stakeholders. And they may be designed to serve differing functions: one may be designed simply for use as an internal management tool, another as a means to achieve external legitimacy.

A three-dimensional EMS typology was constructed to compare and contrast the kinds of EMSs that NDEMS facilities built. Within this typology, facility EMSs were rated along three dimensions: EMS goals, involvement (breadth of participation in EMS development), and degree of external legitimacy sought. Each facility's EMS was located in relation to these three axes and within the three-dimensional space circumscribed by them, and cluster analysis as used to identify patterns of groupings within this space. EMS goals ranged from a narrow emphasis on regulatory compliance to the addition of pollution prevention and eco-efficiency and, in the most ambitious cases, product stewardship and a broader vision of environmental sustainability. Involvement ranged from the Environment, Health and Safety (EHS) staff alone to the addition of other managers, non-management employees, external groups, and in the most open cases external individuals. Degree of legitimacy ranged from EMSs developed for

internal management purposes only to the addition of self-certification, external audits, ISO-14001 "readiness", and in the strongest case ISO 14001 certification.[145]

Results of this analysis showed three distinctive types of EMSs: "Middle-Roaders," which did not reach for high-level goals nor involve many stakeholders in design, and whose EMSs were less likely to be certified; "Efficiency Experts," whose EMSs were more likely to be ISO 14001 certified and which focused on eco-efficiency; and a small cluster of "Visionaries," whose EMSs included more far-reaching environmental sustainability goals and broader participation in EMS development than the others.

For the 14 "Middle-Roader" facilities, the EMS was a means to achieve and maintain compliance and to focus on pollution-prevention activities such as waste minimization and recycling. Most had few environmental management programs in place prior to beginning the EMS development; for them, development of an EMS was a way to get a handle on increasingly complex environmental issues and to increase environmental management capacity within the facility. "Middle-Roaders" most often used EHS staff and facility managers to develop their EMSs; most did not seek ISO 14001 certification.

A majority of the 33 "Efficiency-Expert" facilities used their EMSs to increase the eco-efficiency of their production processes and to achieve ISO 14001 certification. Efficiency experts often had reliable environmental management programs in place prior to designing their ISO 14001-conformant EMSs. These facilities were consistently in compliance with environmental rules and regulations, and had long relied on pollution-prevention plans to achieve waste minimization, recycling and input substitution goals: many had employed waste-minimization practices and pollution-prevention planning for at least eight years, and more than half had used compliance audits for over 10 years. Efficiency experts focused on increasing the efficiency of production processes through more effective use of process inputs, natural resources and energy.

Some facilities in this group went so far as to describe their pursuit of ISO 14001 certification as a race, with the goal of being the first facility in their larger organization or sector to achieve it. The Efficiency-Expert group also tended to rely primarily on EHS staff and facility managers to develop their EMSs, rather than inviting broader participation. The majority of them did not involve non-management employees or external stakeholders in EMS development, perhaps in an effort to minimize time spent on EMS development.

Finally, the six "Visionary" facilities designed EMSs to achieve product stewardship and environmental sustainability goals. Compliance, pollution prevention, and eco-efficient process goals were included as well, but these facilities' EMSs went beyond these to incorporate additional EMS goals focusing on product stewardship issues such as product disposal effects and on examining impacts on sustainability beyond the facility boundary. Visionaries did not necessarily have longstanding environmental management programs to build upon in designing their EMS, as did some of the Efficiency Experts, but these facilities used the opportunity of developing an EMS to incorporate ambitious goals.

The Visionary facilities built EMSs with the help not only of EHS staff but also of other managers, non-management employees and in one case, assistance from external stakeholders.

[145] In an international study, certification to the European EMAS standard would represent an even higher level of external legitimation, but such certification is not generally available to U.S. facilities.

All six Visionaries engaged external auditors to assist them in measuring the adequacy of their EMSs, but had not sought or declared an intention to seek ISO 14001 certification, although they did not discount the possibility that they might pursue certification in the future. One facility also provided opportunities for a community group to review the results of the external EMS audits.

CASE STUDIES

The report includes seven brief case studies of facilities illustrating the three broad EMS types and the varied patterns of goals, involvement practices, and external legitimacy aspirations described in the typology. Examples include one "middle-roader" facility, four "efficiency experts," and two "visionaries." The cases also shed light on key factors that were especially influential in particular organizations, including particularly prior experience and capabilities, anticipated demands of business customers, and the roles of key senior managers or other influential personnel as leaders and advocates for EMS introduction.

EMSS IN GOVERNMENT FACILITIES

Many government facilities have predictable types of aspects and environmental impacts that could be significantly improved through the use of EMS procedures. Examples include motor pools, construction and maintenance operations, water supply and wastewater treatment facilities, schools, universities, hospitals, and others. Other government units also have distinctive environmental management missions less commonly found in the private sector, for which EMSs might provide a framework worth consideration: examples include multi-purpose management of public lands and waters, and management of other common-property resources such as fisheries, wildlife species and ecosystems. Government facilities also face different incentives and constraints than private-sector organizations, and often less access to internal resources and capabilities, all of which may affect both their adoption and their successful and cost-effective use of EMSs.

An EMS provides government facilities with a dynamic and flexible framework for managing their environmental missions, obligations and risks more effectively. Information collected from the public-sector pilot facilities indicates that EMS implementation integrates well with existing compliance, health and safety programs and provides government owned facilities with additional incentives and management tools to meet regulatory and compliance responsibilities. Where prior to EMS adoption organizations had described their environmental goals primarily in terms of compliance with environmental laws and regulations, after EMS implementation many facilities began seeking opportunities to prevent pollution, to reduce the demand side of their operations, and to initiate programs for non-regulated issues like odor management and energy efficiency.

EMSs have been shown to be applicable to operations managed by state and local governments as well as federal facilities. The reported impact of EMS implementation in government facilities was positive, despite relatively few documented quantifiable economic benefits. NDEMS participants found their EMSs to be a useful tool for managing environmental issues, promoting compliance and pollution prevention approaches, increasing environmental awareness and stewardship, and improving operational control and efficiency. Overall benefits included better operational control, better understanding of the root causes of

noncompliance, improved operational efficiency and cost savings, improved communications within the organization and with outside stakeholders, and better relationships with regulators.

Keys to successful EMS implementation in study facilities included management leadership understanding and involvement in the EMS process, building on existing organizational processes and procedures, selecting an implementation team that had cross-functional representation and support, and acceptance and involvement from employees throughout the organization.

The costs associated with implementing EMSs, although significant, were primarily from increased labor hours of the workforce and the hiring of external consultants, both of which could be anticipated to diminish over time as each facility became more adept at implementing their EMS. Other barriers to EMS adoption included management issues (integrating new approaches in strongly bureaucratic organizations); insufficient leadership, visibility and involvement from top management; organizational issues (time, employee buy-in); lack of public awareness; understanding and buy-in; and political uncertainty.

The costs of EMS introduction for such facilities could perhaps be significantly reduced through the use of government EMS assistance programs to provide widely-applicable EMS templates for such facility types, thus helping to fill a parent-organization assistance role that has been valuable to private-sector facilities but largely lacking so far for government facilities.

LESSONS FROM ATTRITION

Over the five-year period from the initial Baseline Protocol to the EMS Design and First and Second Update Protocols, the number of facilities providing data gradually diminished from 83 facilities to 58 (EMS Design), 37 (First Update) and ultimately 30 (Second Update). A comparison of facilities that remained in the study versus those that did not provided some evidence that attrition from the study was probably due primarily to resource constraints, and also associated with major disruptive changes affecting late-stage attrition by some facilities. It appears, in short, that many of the facilities that dropped out of the Pilot Program and the National Database study did so most often because of a lack of resources, often directly expressed as a loss or shortage of personnel, and often in association with a major disruptive event. However, these changes did not appear to have had a strong detrimental impact on the commitment of these organizations to continue to develop and implement their EMSs. While a high rate of adverse events and loss of resources may explain attrition from the NDEMS Pilot Study, these factors did not distinguish the facilities that continued their EMSs from the group that did not do so.

Even among those facilities that did complete all four protocols over the five years of the project, 17 percent (and approximately one third of all facilities) reported that they were not continuing their EMSs. The few explanations given for this attrition from the EMS process more generally cited varied reasons – cultural conflicts within the organization, a fire, other events – but the most frequent explanation was a lack of resources, especially personnel.

STUDY LIMITATIONS

As noted in Chapter 1, the data used in this study, and the findings derived from it, have important limitations that should be noted by users.

First, the number of facilities included is too small and too diverse to generalize about the practices of all facilities. The database consists of a heterogeneous group of 83 facilities, enough to document many important similarities and differences but not enough to produce statistically conclusive generalizations about entire industrial sectors or about the performance of all EMS adopters. For many of the analyses, the number of facilities for which data are available is less than 83, since not all facilities responded to all the data requests.

Second, the facilities we studied were volunteers recruited by EPA or state environmental agencies, most of which received favorable government recognition and many of which received government technical assistance for developing their EMSs. As such, they may not be fully representative of facilities that introduced or chose not to introduce an EMS in the absence of such inducements, and their EMSs may themselves have been subject to some homogenization due to the common influence of government technical assistants.

Third, the facilities may not all have provided complete or unbiased information. Participating facilities have been extremely generous about sharing data with this project, but in at least a few known instances they have found it necessary to withhold specific data elements to protect confidential business information, and there may be additional unknown instances as well. Some of the information in this study reflects the judgments of the individuals who provided us the information, who may also have biases favoring the success of their EMSs.

Fourth, our results compare EMS practices during a particular time period (1998-2002), a long enough period and late enough after introduction of the ISO 14001 model to learn a great deal about the EMS adoption process and its initial impacts, but still too soon to expect objective evidence of change in performance and compliance outcomes to be clearly evident in government data sets.

Finally, facility-level data on U.S. implementation practices do not by themselves answer all important questions about the value and effectiveness of EMSs. Some important EMS-related decisions and practices may require investigation at the firm or corporate level, and international comparisons are necessary to determine whether similar or different motivations and practices occur in facilities located in countries other than the United States. Examples include the possibility that European facilities registering EMSs to the EMAS standard may show stronger performance than firms registering only to the ISO 14001 standard, or that Asian businesses may be motivated more strongly than U.S. facilities to use ISO registration as a factor in competition for U.S., European and Japanese business customers.

Such limitations are unavoidable in a detailed longitudinal pilot study such as this, and are offset by the distinctive benefits of this type of study. A comparative study using volunteer facilities allowed us to collect far more detailed information on each facility than could be gathered by mail or telephone surveys of large numbers of organizations, and to obtain far richer qualitative as well as quantitative information about how their EMSs were developed. Case studies also allowed us to illustrate more specifically the similarities and differences among their experiences. Finally, the longitudinal design allowed us to monitor and interact with these facilities over a far longer period of time, through a critical period in the evolution

of their management practices, than would have been possible in a one-time survey or other types of studies.

FURTHER RESEARCH NEEDS

A number of important questions deserve continuing investigation beyond the time period and evidence of this study:

- How does the performance of the EMS pilot facilities compare with the performance of the full universe of facilities that introduce EMSs, and particularly with those that start with more serious deficiencies in environmental performance and regulatory compliance?
- What will the experience of such facilities be beyond the initial 1-2 years after EMS introduction? The objectives and targets actually set and achieved by each facility will be among the most important subjects for future examination.
- Do public reporting and broad stakeholder participation produce better environmental performance results?
- How will government incentives for EMS adoption and use – public recognition and regulatory flexibility, technical assistance, enforcement agreements, and others – affect environmental performance and compliance over the longer term? Do facilities that rely heavily on external resources or participate in enforcement agreements develop EMSs that are as rigorous, and that improve as well over time, as the EMSs developed by facilities entirely on their own?
- How do successful EMS adopters overcome implementation issues, and what models do their experiences offer for success by subsequent adopters?
- How do facility-level EMS decisions interact with decisions made at the level of a larger corporate or government organization? How do their aspects, impacts, judgments of significance, and potential objectives and targets differ from those available at the facility level?
- How can EMSs be used most effectively to improve the performance of government facilities?
- How do U.S. facilities' uses of EMSs compare with those in other countries?
- Do externally audited and certified facilities demonstrate superior environmental performance than non-certified facilities?
- Can groups of facilities in the same community or ecosystem achieve more significant results by coordinating their EMS objectives and targets?

IMPLICATIONS FOR PUBLIC POLICY

The findings of the NDEMS pilot study indicate that government policies and incentives make a difference to EMS adoption, and to the degree of success that these systems can achieve during implementation. Which policies and incentives, and with what effects on which kinds of facilities, are important questions for further consideration in the design of public policies.

First, for instance, the report found that EMS adoption and success are influenced both by external pressures – including regulatory expectations in particular -- and by the resources and internal capacity available to the facility to do so. Government policies enter into both these considerations.

Regulatory pressures, for instance, were perceived by all types of facilities as the most important external influences on their decisions to adopt an EMS, and other government incentives such as public recognition programs may also be influential. If decisions about EMSs and other voluntary initiatives are made in the context of continued expectations about regulation, it will be important to assure that those expectations are maintained. In this context, EMSs may function not so much as alternatives to such regulation as instruments for improving compliance assurance along with other objectives such as eco-efficiency (and in some cases, more visionary organizational objectives such as environmental stewardship and sustainability). In light of these findings, it will also be useful to consider further when to use regulatory pressure for EMS adoption and performance and compliance improvement, and on what types of facilities. For which categories of potential EMS adopters does it work best as a motivator?

Government capacity-building assistance programs -- technical assistance programs, templates for EMSs, best-practices conferences and workshops, and other support, for instance – were also reported to be important but different influences on EMS introduction, especially for privately-held facilities, for facilities that are not subsidiaries of a larger parent organization, and for government facilities. These findings suggest possible criteria for targeting of public policy incentives and assistance services on organizations for which they will be most valuable and effective.

Second, the report found that facilities' prior histories matter to EMS adoption and success. These histories include both their prior compliance histories, and their prior experiences with other capacity-building initiatives: management innovations such as ISO 9000, other environmental management initiatives such as pollution prevention plans, and initial elements of an EMS per se. The influence of these prior histories on subsequent environmental performance suggests additional implications for public policy design. Facilities with more problematic compliance histories and more limited capacity histories may need stronger combinations of incentives and assistance – and probably, different combinations of these – than facilities that start from more favorable pasts. Which potential EMS adopters is it worthwhile to motivate? The better implementers appear to have stronger managerial and other capacity characteristics: would they then be the best population of adopters to try to increase? On the other hand, policy incentives that focus mainly on facilities with favorable compliance histories and prior capacity development may achieve apparently greater success, but may simply be rewarding those facilities that were more likely to succeed anyway.

Third, the fact that government facilities themselves had distinct differences from private-sector facilities has important implications both for implementation of the presidential executive order on EMSs and for EMS adoption and success by government facilities. In particular, government facilities typically had markedly less prior capacity developed for environmental management than businesses, and they were far more reliant on consultants and other higher-cost services. They also were typically more focused on the use of an EMS for regulatory compliance assurance than on other potential benefits such as cost savings.

These findings suggest the particular importance of capacity-building assistance for public-sector facilities, and perhaps of additional emphasis on cost-saving as well as environmental performance indicators as benefits of an EMS to public-sector facilities. They also suggest that continued and increased emphasis not just on EMS procedures per se, but on more substantive related environmental management capabilities – pollution prevention plans, for instance – may be warranted for public-sector facilities in particular. It may be that public-sector facilities should also be encouraged more explicitly to develop their own internal capacities for ongoing and continual improvement of environmental management, rather than continuing to rely more heavily than businesses on consultant services.

Fourth, the report's findings showed that EMSs vary widely in their content. An important implication of these findings for public policy is that the content of an EMS—the scope of activities, products and services considered, the impacts whose significance is identified or overlooked, the objectives and targets selected for improvement, and the organization's actual performance in achieving them—will probably prove to be far more important and informative as a basis for public policy rewards and other incentives than the mere existence of an EMS or even the fact of ISO 14001 EMS registration.

Finally, the report's findings identified potentially important differences of several kinds among facilities that focused their EMS processes on compliance and capacity-building, on eco-efficiency, or on more visionary innovation strategies. It may be important for public policy makers to consider carefully which of these approaches they most wish to encourage, and to differentiate their strategies and incentives accordingly.

Left unexamined by this study, but deserving of future investigation, are the implications of EMS use as an element of enforcement and sanctions policies. EPA and a number of state environmental enforcement officials have begun to experiment with including EMSs as "supplementary environmental projects" within negotiated enforcement settlement agreements. It will be important to determine whether such EMSs add significant value to improvement of compliance rates and related performance outcomes in facilities that start with more problematic compliance and performance records than the NDEMS pilot facilities.

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Appendix B. An EMS Research Bibliography

This appendix provides a research bibliography on environmental management systems and related literatures, in five sections: environmental management systems per se, business decision making and the environment (other than EMSs), environmental policy, management decision making more generally, and total quality management.

The bibliography is limited primarily to research literature: we have made no attempt to include the large consulting and trade literatures on EMSs, nor the mass media or advocacy-group publications related to this subject. The goal is to help both researchers and policy makers to identify the existing body of research on this subject, so that they may move on from that foundation and not unintentionally overlook or duplicate work already available.

The first section, on environmental management systems per se, is intended to be reasonably comprehensive as of the date of publication (January 2003), although it is of course a continually growing literature. The other sections do not attempt or purport to be comprehensive, but do capture a range of key publications in each of these related subject areas that the NDEMS research team has found useful and relevant to the study of EMSs.

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Appendix C. Related Assessments

Within the overall context of the NDEMS pilot study, several participating organizations also conducted formal assessments of EMS adoption and its consequences. The findings of these studies are summarized below.

CALIFORNIA

California supported EMS development in ten pilot facilities,[146] and evaluated their consequences both for improving public health and environmental protection beyond regulatory requirements, and for providing greater information on public health and environmental effects to the public (CalEPA, 2003). The California project also examined incentives, barriers, and challenges to EMS implementation, and examples of successful implementation.

Cal/EPA's final report on its program concluded that EMSs can have a positive effect on environmental protection and increase protection above the level mandated by a facility's regulatory requirements. Some improvement in environmental performance was observed at all pilots reporting performance data. The range of improvement, however, varied between pilots, with some reporting significant change while others reported only moderate gains. The vast majority of performance improvements were observed in non-regulated areas. With the exception of pollution prevention goals for hazardous waste and toxic releases, objectives and targets were more likely to be set for non-regulated media.

While no clear trend in compliance improvements was observed in the EMS project, many pilots had a better recognition of, and response to, compliance issues. In some cases, pilots who had no violations before the EMS was put in place continued to have no violations afterwards. In other cases, pilots who had violations before the EMS had some violations after the EMS was put in place, but had better systems in place to respond to problems swiftly. The report also concluded that EMSs can be an effective pollution prevention tool.

In general, the California report concluded that pilot facilities performed well in comparison to regulatory requirements and demonstrated performance exceeding regulatory limits, but that an EMS cannot guarantee environmental protection beyond an organization's regulatory requirements noir even ensure regulatory compliance. Only one facility actually set specific objectives to improve performance beyond regulatory limits. The EMS also was responsible for improved compliance with regulatory standards at one facility, and another demonstrated performance well beyond regulatory limits but because their EMS evolved over many years it was difficult to attribute this to their ISO 14001 certified EMS.

[146] One was subsequently dropped from the project due to a serious enforcement issue.

The California study also reported observing several trends in environmental performance improvement. Pilots that were still in the process of developing their EMSs generally did not report gains in environmental performance improvement. Pilots that had developed them and were in the early stages of their implementation experienced significant improvements, and showed great potential for future gains. Pilots with more mature EMSs, on the other hand, showed signs of reaching performance limits.

More generally, Cal/EPA observed organizational change from cultures of compliance maintenance or avoidance to ones of continual improvement and environmental protection beyond regulatory commitments, and concluded that a systems approach towards environmental management yields beneficial results. Pilot organizations demonstrated increased awareness of their environmental impacts and responsibilities through aspect and impact assessment and through the identification of legal and other requirements. Their environmental policies and objectives and targets established greater commitments to environmental protection than was observed prior to EMS implementation. These changes established a basis for further system changes and improved performance.

The EMSs evaluated in California's pilot project also generated new and useful information on the nature and extent of impacts not required by law or regulation. EMSs proved better in providing information on the nature of impacts, however, than on their extent. Also, the scope of information or access to that information were often limited: pilots willingly shared EMS information with the project's stakeholder work groups, which included members of the public, but the general public did not have this same access.

With respect to economic impacts, two of California's pilots provided specific economic data, and two others reported anecdotal information on economic costs and benefits. The California report found that potentially significant cost savings resulting from EMS implementation could provide incentives for organizations implementing EMSs. One large pilot facility saved over $1 million per year between 1992 and 1999, for example, and a small facility was projected to save $116,896 per year due to EMS implementation. These savings primarily resulted from increased efficiency in the use of resources and materials. EMSs also required economic investment, however, and long payback periods could act as a barrier to EMS implementation, especially for small companies.

Finally, the California report identified challenges to EMS introduction in several areas. Examples included leadership and commitment, strains on resources, integration of EMS into the organization, technical complexity and assistance, goal setting, measurement and feedback, and stakeholder involvement. All of these represented potential barriers or inhibitors to improved environmental protection.

Finally, the California assessment concluded that government support of EMSs could improve environmental protection, particularly by convening voluntary partnerships (for instance, involving particular industrial sectors and geographic regions); using performance targets and recognition as drivers and incentives; exploring the development of a special regulatory track for high-performing organizations; providing grants, templates, and implementation guides; and serving as a clearinghouse for economic data on EMS implementation.

NEW HAMPSHIRE

The New Hampshire Department of Environmental Services (DES) sponsored five pilot projects, most involving small or medium-sized enterprises (SMEs), with the hope of developing a generic EMS template for use by SMEs. This hope proved unrealistic, owing to significant differences in characteristics and sectors among SMEs.

The first lesson reported by DES from its pilot projects was that systematic, proactive management of environmental impacts through an EMS was better than reactive, crisis-driven management. New Hampshire firms that implemented EMSs reported anecdotally that the effort pays for itself through cost savings. As in California, most of the reported cost savings were in non-regulated areas such as energy use. The least economically favorable result reported to DES was that the EMS effort was a break-even proposition, and even in that case, the firm reported that the effort was worth it because with the EMS in place, the firm had better relations with the environmental agencies and with their neighbors.

Second, DES concluded that the time and effort necessary for EMS development was a significant undertaking, especially for small businesses. This was particularly true due to the findings that SME decision makers often have no 'management' skills and that often no resources were available to devote to system development. As DES' report noted, when the CEO is also the production manager, the human resources administrator, and the health and safety officer, there is simply no time to step back to assess and build a management system. Specific parts of the ISO 14001 EMS that were problematic for smaller businesses included development of standard operating procedures for operational control; identification and ranking of environmental aspects and impacts; establishing a formal management review process; establishing a document control system; and establishing procedures for both external and internal communication.

DES concluded that one could expect improved regulatory compliance, though no guarantee of full compliance, from firms that use an EMS. In several cases, vigorous enforcement had the effect of convincing companies to manage their environmental affairs more effectively, thus driving them to implement EMSs. DES also concluded that having a system in place that would prevent recurrences acts as a mitigating factor in computing penalties. In DES's view, environmental enforcement personnel were coming to the understanding that many violations resulted from ineffective management of environmental affairs, as opposed to malicious behavior; and that in such cases, an EMS could be used effectively as an element of enforcement settlements. DES has done this in one case, involving the state transportation agency, and the chief of DES's RCRA enforcement section reported that inspections at a facility with an EMS in place were significantly easier, especially noting that records were easier to obtain at such a facility.

Finally, state assistance was a determining factor in motivating each of the first three pilot facilities to develop an EMS. Of these, the company that progressed the furthest was the one that had the clearest commitment from upper management, and had staff from throughout the organization involved in EMS development. On the other hand, both of the firms in New Hampshire's second round of pilots already had ISO-9000 systems in place, and both were suppliers to the automotive industry. They joined DES's project before the major automotive manufacturers mandated EMS development by their suppliers, but both were aware that such

a requirement was on the horizon. Thus they had motivators that the other three lacked, as well as greater prior knowledge of management systems.

PUBLIC-SECTOR PILOT PROJECTS (GETF)

Finally, the U.S. EPA Office of Water sponsored EMS pilot projects by two cohorts of public-sector facilities that were included in the NDEMS database, coordinated and evaluated by the Global Environmental Technology Foundation (reports available at http://www.getf.org). These comprised 23 facilities, most of them municipal facilities such as wastewater treatment plants, solid waste and other municipal departments, and transportation authorities, but also including a state university, a state agency, a correctional institution, and a port authority.

Information collected in these projects suggested that EMSs are entirely applicable to operations managed by local governments. Without exception, participants found the EMS to be a useful tool for managing environmental issues, promoting compliance and pollution prevention approaches, increasing environmental awareness and stewardship, and improving operational efficiency and control.

GETF found that a number of aspirations motivated public-sector organizations to apply for participation in the EMS initiative. These included environmental compliance assurance; organizational goals such as improving efficiency, worker health and safety concerns, employee morale, and reduced costs; public image and credibility concerns; improved regulatory relationships; competitiveness (in the face of privatization initiatives); growth management agendas, such as using an EMS as an incentive to attract the right type of industry and send a message that the city has a strong environmental consciousness; and a desire to promote the role of municipalities as leaders and innovators.

Benefits reported by the participating facilities included positive effects on environmental compliance and performance; stronger operational controls and increased productivity; savings in consolidated permitting programs; improved environmental awareness, involvement and competency throughout the organization; better communication about environmental issues inside and outside the organization; improved efficiency, reduced costs, and greater consistency; and better relationships with regulatory agencies. Specific examples of benefits reported included $706,000 savings in heavy equipment rates; a $1/16^{th}$ to $1/8^{th}$ of a point improvement in bond rating; a 20 percent reduction in insurance premiums as a result of EMS documentation and operational controls; reduction of fuel consumption by 90,000 gallons, and of CO_2 emissions by 9 tons; and one-year monetary savings of $63,631.

Specific environmental benefits identified in the municipality study included reduction in solid waste quantities, decreases in disposal costs due to technologically induced reduction in the quantities of solids at a sewage treatment facility, stronger compliance programs, and more controls on non-regulated impacts (for instance, odor management and energy efficiency).

The nature of the benefits often depended on the stage of the implementation process. For example, during the initial stages of implementation, the benefits fell in the areas of improved communication and/or eliminating redundancy in roles and responsibilities; however, as the projects progressed the participants began realizing cost savings, increased operational efficiency and improved environmental management.

The bulk of the costs involved direct labor costs. On average, each participating organization committed 4,331 direct labor hours totaling $126,223 in internal costs over the two-year period of the project, with low values averaging $67,102 and high values averaging $195,565. Costs of EMS introduction by public-sector pilot facilities averaged $43,00-$56,000 in staff time for facilities of less than 150 employees, and $130,000 for facilities of over 1,000 employees. Ten of the 23 facilities also sought consultant assistance, at costs ranging from $2,400 to $23,000 for all but one of them and $143,000 (for 1,110 hours of work) by one outlier organization that chose to rely unusually heavily on a consultant.

The principal barriers reported by these organizations included the difficulties of managing organizational change; lack of top management visibility and involvement; organizational constraints, particularly time; lack of public awareness, understanding and buy-in; and political uncertainty, especially in relation to continued support through changes in elected administration.

Key success factors included top management commitment and support; building on existing organizational processes and procedures; an effective implementation team; training; and employee awareness, understanding and involvement across the entire organization, including recognition of EMS development as an organizational priority.

Appendix D. Research Protocols

The following research protocols are included electronically on a CD attached to the back cover of Volume II:

BASELINE PROTOCOL

EMS DESIGN PROTOCOL

FIRST UPDATE PROTOCOL

SECOND UPDATE PROTOCOL

CASE STUDY PROTOCOL

Appendix E. National Database on Environmental Management Systems

The following components of the National Database on Environmental Management Systems are included electronically on a CD attached to the back cover of Volume II:

BASELINE DATABASE

EMS DESIGN DATABASE

FIRST UPDATE DATABASE

SECOND UPDATE DATABASE