

# Environmental Management Systems: Opportunities for Improved Environmental and Business Strategy?

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*Less than four years after publication of ISO 14001, thousands of organizations worldwide have adopted the standard. In this article, researchers working with the National Database on Environmental Management Systems (NDEMS) review some preliminary data on organizations' experiences with EMS adoption and implementation. Their findings indicate that, although organizations may face hurdles in implementing EMSs, the majority believes the benefits outweigh the drawbacks. © 2000 John Wiley & Sons, Inc.*

The widespread adoption of formal environmental management systems (EMSs) by businesses and other organizations has the potential to alter profoundly both their environmental and economic performance, and their resulting relationships with suppliers, customers, employees, and environmental regulatory policies and agencies.

Since the 1970s, many businesses have developed their own environmental management procedures, although environmental management largely remained the responsibility of a single manager who was responsible primarily for regulatory compliance and risk minimization, rather than an organization-wide mission for which all managers would be held accountable. In late 1996, however, the International Organization for Standardization published the final version of an international voluntary EMS standard, called ISO 14001. Since then, businesses are increasingly adopting ISO 14001 and other types of EMSs so that they may better integrate environmental considerations throughout their operations in order to more effectively and efficiently manage their environmental impacts.

## **BACKGROUND: ENVIRONMENTAL MANAGEMENT SYSTEMS**

An EMS is a formal set of procedures and policies that define how an organization will manage its potential impacts on the natural environment and on the health and welfare of the people who depend on it. It creates a system to assess, catalogue, and quantify facility environmental impacts—not simply activity by activity, but throughout the entire company.

The goal of EMS adoption is to help organizations ensure that their operations comply with environmental laws and that major environmental risks, liabilities, and impacts are properly identified, minimized, and managed. An EMS supplies the framework to do so by creating a structure to:

- adopt a written environmental policy;
- identify the environmental aspects and impacts of operations;
- set priorities, goals, and targets for continuous improvement in environmental performance;
- assign clear responsibilities for imple-

- mentation, training, monitoring, and corrective actions; and
- evaluate and refine implementation over time so as to achieve continuous improvement both in implementation of environmental goals and targets and in the EMS itself.

Once a facility implements its EMS, in theory, it will not only be in conformance with all environmental regulations, but it may also surpass the regulatory standards for many environmentally regulated activities, and may identify opportunities for reducing non-regulated environmental impacts of its activities as well. Facilities that adopt EMSs and are able to reduce their environmental impacts beyond regulatory standards may also lessen their environmental reporting burdens and the costs associated with them.

In doing so, businesses may redesign their operating structure, substitute unregulated inputs for regulated ones, and eliminate some regulated processes altogether so that they may no longer be subject to costly regulatory mandates. In the process, it is likely that facilities will discover new opportunities to prevent rather than merely control their pollution, and to reduce wasteful uses of resources, thus saving money while improving the environment. They may also discover opportunities to manage their organizations as a whole more effectively.

Since its development in 1996, over 10,000 facilities worldwide have had their EMSs ISO 14001 certified. In the United States, certification has also expanded rapidly, from 169 facilities in 1996–98 to approximately 400 facilities by autumn 1999; within the next year, this number is expected to increase by approximately 50 percent.

But while facilities are adopting ISO 14001 at a rapid pace, little is known about them or about why the voluntary environmental management standard is being adopted at all. This article identifies some

of the reasons why facilities are implementing ISO 14001 EMSs based on preliminary information from 19 facilities and the results from two more detailed case studies.

### **WHY ARE FACILITIES ADOPTING ISO 14001 EMSs?**

Some businesses have experimented with EMSs for many years. Companies such as 3M and IBM, for example, each began implementing portions of their EMS over 25 years ago. Yet, prior to 1996, there was no major trend toward widespread adoption or standardization, perhaps due to a lack of international acceptance and understanding of the economic rationale. Publication of the ISO standard, however, changed this trend as it generated great interest in the business community and has prompted hundreds of facilities to adopt an ISO EMS.

While it is still speculative what factors motivate facilities to adopt ISO 14001, there is some preliminary evidence suggesting that international trade influences, supplier preferences, public relations pressures, customer preferences, shareholder interests, environmental performance factors, compliance pressure, and other motives may play a part. Additional research is needed, however, to determine which of these are most influential and for what types of firms.

The preliminary evidence indicates that business interest in ISO 14001 EMSs is particularly notable in several international markets such as Europe and Asia, where certification may in the future be viewed as a prerequisite for trade. For this reason, many U.S. multinational corporations are interested in the potential that ISO 14001 may have for their ability to operate in international markets. In some European markets, for example, trade preference is given to facilities that adopt the European version of a certified EMS, called EMAS, the Eco-Management and Audit Scheme.

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U.S. firms that operate domestically also have shown interest in ISO 14001, and in its impact on their relationships with suppliers, as well as the purchasers of their goods. Some business purchasers and government procurement officers already require that ISO-certified organizations receive greater preference than non-ISO-certified firms in their purchasing decisions, as these firms may signal their explicit commitment to systematic environmental management and continuous improvement in their environmental performance. General Motors, for example, has announced that it will require all its suppliers to adopt ISO 14001 EMSs by December 31, 2002. Similarly, Ford Motor Company has mandated that all its suppliers be ISO 14001 certified by July 1, 2003. Widespread company mandates such as these have the potential to profoundly impact supply chain relationships.

In addition to affecting facilities' operations management, the preliminary evidence shows that ISO 14001 EMSs have the potential to influence other aspects of company operations, including consumer and public relations. As much as 10 years ago, estimates of the sale of "green" products were over \$120 billion per year (U.S. EPA, 1990). Following this trend, more than 75 percent of U.S. consumers considered a company's environmental image in their shopping decisions (Kleiner, 1991). Consistently, consumers attested that the environment, broadly defined, was near the top of the list of public concerns (Portney, 1993). Given this history of consumer interest in the environment, the demand for green products is expected to drive more purchasing decisions in the next decade.

Facilities that are ISO 14001 certified may better satisfy these consumer demands for environmentally conscious products. Moreover, ISO 14001 facilities may be better positioned to market their products as environmentally friendly and to bolster their environmental reputation.

Each of these factors may grant ISO-certified firms a competitive advantage and help them to reap greater financial rewards than their non-certified competitors.

Increased product sales, consumer satisfaction, and environmental efficiency may also translate into increased shareholder gains. As the ultimate owners of a corporation, shareholders stand to profit by a company's good environmental deeds. Because ISO-certified facilities have in place a system that, over time, has the potential to reduce their environmental impacts (as well as their related health and safety liabilities) and bolster the facility's public image, they may experience enhanced financial performance at rates that exceed those of non-certified facilities, although this is not yet proven.

There are additional potential financial impacts to facilities that adopt ISO certified EMSs. The ISO standard requires a procedure for identifying and complying with regulations. So, in theory, a facility that adopts an ISO 14001 EMS will comply with all environmental regulations and reduce its emissions well below the regulatory standards thresholds, thus lessening its environmental reporting burdens and the costs associated with them.

Other preliminary evidence shows that businesses consider ISO 14001 certification as an opportunity to send a strong signal to regulators about their commitment to minimize their impact to the natural environment (Klassen & McLaughlin, 1996). If compliance is ensured, then facilities that adopt a certified EMS have minimal threat of punishment by regulators. For this reason, U.S. environmental regulators are trying to evaluate the businesses that adopt these systems to determine their potential for future public policy.

#### **NATIONAL DATABASE ON ENVIRONMENTAL MANAGEMENT SYSTEMS (NDEMS)**

Over the past three years, the U.S. Environmental Protection Agency (EPA) and

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ten states participating in the Multi-State Working Group on Environmental Management Systems (MSWG) have provided technical assistance, financial grants, enhanced publicity, and regulatory flexibility in various forms to 70–100 pilot facilities that are adopting ISO 14001-based EMSs. In exchange, the pilot facilities have agreed to provide data on their EMS development process, as well as on their pre- and post-implementation performance, to the National Database on Environmental Management Systems (NDEMS).

The development of this database, which is a joint research effort between the University of North Carolina at Chapel Hill (UNC) and the Environmental Law Institute, is funded by the U.S. EPA. The pilot facilities and NDEMS offer a rare opportunity to study the EMS implementation processes and to identify the effects of EMS adoption on facility performance in real time.

NDEMS will include EMS implementation data from the pilot facilities plus approximately 20 non-pilot “control” facilities, all of which are using identical data collection protocols. The NDEMS data will help to determine the effects of ISO 14001 and other EMSs on five kinds of outcomes:

- environmental performance;
- regulatory compliance;
- pollution prevention;
- engagement with stakeholders; and
- economic performance.

All information about the database may be found on the Internet at the NDEMS homepage at <http://www.eli.org/isopilots.htm>. This site includes the NDEMS research protocols, periodic public reports, and other papers, guidance, and policy documents. In the future, the database itself will be available at this site once the data are quality checked and the sample is of adequate size.

## **EMS ADOPTION IN PRACTICE: PRELIMINARY RESULTS FROM TWO CASE STUDIES AND 19 NDEMS FACILITIES**

Already, preliminary NDEMS data on EMS design and implementation have been analyzed from two in-depth case studies, “Alpha Manufacturing” and “Beta Municipality.” (Because of the anonymity agreement between UNC and each of the NDEMS facilities, all facility names have been changed to protect their identity.) A full summary of these case studies will be available in spring 2000 at the NDEMS homepage National Database on Environmental Management Systems’ homepage at <http://www.eli.org/isopilots.htm>. The case studies are supplemented by NDEMS data from 19 facilities that represent eight industrial sectors in ten states.

The preliminary results show that, in contrast to early presumptions that only larger transnational corporations would adopt EMSs, such systems in fact are being implemented by facilities of all sizes and in many sectors. The first case study, Alpha Manufacturing, is an example of a smaller facility that has decided to adopt ISO 14001.

### **Case Study 1: Alpha Manufacturing**

Employing fewer than 100 full-time employees, Alpha is a privately held manufacturing facility located in the Midwest. It has been in operation since the early 1980s and is a Tier I supplier to the automotive industry. Prior to adopting its EMS, Alpha participated in both U.S. EPA’s 33/50 Program (which helped it to voluntarily reduce its toxic chemical emissions) and EPA’s Common Sense Initiative. Alpha also had in place both a pollution prevention plan and a waste minimization plan. Its management systems were recently certified to ISO 14001, ISO 9000, and QS 9000.

Several factors influenced Alpha’s decision to adopt an ISO 14001 EMS. First, because of the facility’s strong presence in

its surrounding community, Alpha decided ten years ago that it should strategically reduce its emissions levels far below legal compliance thresholds. As part of its progression in better environmental management, adopting an ISO certified EMS represented the latest action in a series of activities to both “do the right thing” and help the facility to move beyond compliance.

Alpha is not alone in its direction. Indeed, over half of the 19 facilities that have submitted preliminary data to NDEMS report that one of the most important factors that contributed to their decision to adopt an EMS is to improve facility compliance with environmental regulations.

Alpha’s customers also influenced its decision to adopt an ISO 14001 EMS. Because the automotive industry and other Alpha customers were increasingly asking it to audit its quality and environmental procedures, Alpha believed that obtaining both ISO 9000 and ISO 14001 certification would be beneficial. These systems were adopted concurrently, as the facility estimated that only a marginal level of additional effort would be required for Alpha to adopt ISO 14001 at the same time as it implemented ISO 9000 and QS 9000. It took Alpha approximately 18 months to design and implement its ISO 14001 EMS and obtain certification.

Alpha’s EMS adoption process was not easy; it encountered several hurdles that are likely to be shared by other small manufacturing organizations. The first was related to the ISO 14001 framework itself. Alpha managers found it very difficult to navigate through the standard and to translate the ISO 14001 language into action. For this reason, it had to look outside its organization and hire a consultant to provide the expertise it needed. Alpha attests, however, that the investment in consultant expertise was a wise decision because the consultant provided Alpha

with a bridge between the ISO 14001 standard and EMS design and into EMS implementation.

Like most of the 19 facilities that have submitted their preliminary data to NDEMS, Alpha developed a formal process that was tailored to its operations, and evaluated the environmental aspects and impacts of its processes. Its consultant created the structure for this process. The environmental evaluation was perhaps the most difficult part of Alpha’s EMS adoption, requiring months of discussions, meetings, rankings, and assessment. While Alpha’s managers describe its operations over the last ten years as environmentally progressive, never before had they evaluated all aspects of the facility’s operations and their impacts on the natural environment, determined their significance, and set goals to address them. The task was arduous and often resulted in Alpha managers engaging in heated debates, which their consultant moderated. Indeed, Alpha believes that, if not for its consultant, its EMS design process would have been greatly extended.

The second hurdle that affected Alpha’s ISO 14001 adoption was gaining mid-level managers’ commitment to implementing an EMS. From the onset, mid-level managers were hesitant to allocate the staff time that was necessary to implement Alpha’s EMS. They believed that Alpha’s expected implementation costs exceeded its anticipated benefits. In fact, if it were not for the owner’s insistence that Alpha adopt ISO 14001, the facility most likely would not have implemented a formal EMS.

Alpha managers’ skepticism remained until the facility began its EMS implementation. Managers who were otherwise critical became supportive when they were involved in identifying Alpha’s environmental aspects and impacts, determining their significance, and setting its objectives and targets. Support for the

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system occurred in part because management gained ownership in the design process. Moreover, once mid-level managers progressed through the process of designing Alpha's EMS, they achieved a better understanding of how the facility's environmental management could be improved further.

While Alpha says that adopting an ISO 14001 EMS was a challenge, it also asserts the benefits of its implementation. By far the greatest benefit that Alpha professes is related to the EMS design process itself. It states that designing and implementing ISO 14001 vastly improved the shared employee understanding of the impacts of Alpha's manufacturing activities on the natural environment. Such an understanding has facilitated Alpha's ability to supplement its traditional environmental management practices so that it can continually improve its operations. By improving employees' shared understanding of its environmental goals, Alpha believes that it is better positioned to further minimize its impact on the natural environment.

Another benefit related to the EMS adoption process at Alpha includes developing a written environmental systems manual. Prior to designing its manual, which is a requirement of ISO 14001, Alpha's environmental policies and programs were not well documented (if they were documented at all) and had little formality. The documentation process also prompted Alpha to formally commit to continual improvement of its environmental management. Such a result, Alpha argues, should not be discounted. While Alpha committed itself over a decade ago to go beyond the regulatory thresholds for environmental compliance, the continual improvement requirement of ISO 14001 has tested Alpha's current management practices and challenged its managers to improve upon them.

While Alpha does not currently report a direct economic net benefit from its EMS adoption, the facility did not anticipate

such benefits when it decided to adopt ISO 14001. And Alpha is not alone. Of the 19 facilities that have provided preliminary NDEMS data, approximately one-third indicate that economic considerations (e.g., reducing their costs and improving revenues) did not influence their decision to adopt their EMS. Rather, non-economic considerations, such as improving facility public relations, environmental performance, compliance with environmental regulations, and others, played a greater role. Such findings are particularly interesting as they contrast with early presumptions that facilities would adopt EMSs in order to improve their direct economic net benefits.

For Alpha, a direct financial payoff will likely occur in the future as its customer demands have recently shifted. That is, two of the "Big Three" automobile makers have mandated that all their suppliers (including Alpha) be ISO 14001 certified in the next two to three years in order to do business with them.

Alpha managers state that, after considering their adoption hurdles, they would implement an EMS again even though it may not pay for itself in the short term on any strict economic basis. This is true, too, for most of the 19 facilities that have submitted preliminary data to NDEMS.

### **Case Study 2: Beta Municipality**

In contrast to Alpha Manufacturing, the second case study, Beta Municipality, profiles a large municipality with five departments, several subdivisions, and over 1,000 employees. It is located in the Southwest in an urban/suburban area that, in the last ten or more years, has experienced higher-than-average growth levels. Such growth is placing increasing demands on the municipality's operations and its ability to manage its environmental impacts.

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Program (GLP) and OSHA's Voluntary Protection Program (VPP). While Beta's participation in GLP did not influence its decision to adopt an EMS, its experience with the VPP was particularly influential. The VPP helped the municipality develop a framework to evaluate its health and safety issues on an integrated, citywide basis. This framework facilitated an easier EMS implementation at Beta because the integrated EMS structure was familiar to employees and was recognized as producing meaningful results.

Unlike Alpha, Beta Municipality adopted its EMS with government support. If not for the support from EPA's EMS Municipality Project, Beta states that it probably would not have adopted an EMS. For municipalities, Beta argues, there are fewer reasons to implement an EMS because they are costly to maintain, require much technical support during implementation, and lack a market driver—that is, there exists no competitive market of suppliers and consumers urging EMS adoption. Beta maintains that the U.S. EPA project served as its market driver by providing both the financial and technical support that made its EMS adoption feasible.

There were, however, other factors that contributed to Beta's decision to adopt an EMS. These factors were Beta's historical environmental performance, its desire to maintain a low-risk profile, and its desire to be an innovative operator.

With respect to Beta's historical environmental management, it should be noted that the municipality is still in the process of managing previous environmental errors that occurred over 20 years ago. In the early 1980s, part of Beta's operations became an EPA Superfund site. This site (and the slow pace of its remediation) has strained Beta's relationships with both the state and federal government, as well as with its public critics. In considering this issue, Beta's top management believed that the municipality would be better equipped to preclude future compliance problems,

avoid repeated mistakes, and improve its relationships with stakeholders and state and federal regulators if it adopted an EMS.

Another factor that contributed to Beta's decision to adopt an EMS was its desire to maintain a low risk profile, which is an important performance indicator with respect to the municipality's operations and management. As part of this issue, Beta was concerned about avoiding any catastrophic environmental events and wanted to take a proactive risk management approach rather than a reactive one. Beta's top management believed that adopting an EMS was consistent with this proactive approach.

Finally, Beta has had a long history of innovation. Its "corporate" culture involves trying new management approaches in order to improve upon its current operations. For Beta, EMS adoption was a logical next step in its environmental management strategy.

Like Alpha, Beta's EMS adoption process was not easy. It encountered several hurdles that are likely to be shared by other large organizations. The bureaucracy associated with Beta's large operating structure and numerous departments and divisions created an atmosphere of inertia and resistance to change, and was perhaps the greatest barrier for it to overcome. As with any entity this size, communication among the various departments was not consistent, and managers often disagreed with one another.

In order to transcend its inertia, Beta had to convince its mid-level management that allocating their employees' time to adopting an EMS could benefit both Beta and their department's long-term operating goals. In doing so, Beta (like Alpha) used the EMS design process as an opportunity to thoroughly investigate all organizational activities and identify those that would have a potential impact on the environment. By involving mid-level management in this process, Beta gained their support for the outcomes and for the EMS itself.

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Also like Alpha, Beta had difficulty decoding the ISO 14001 framework. Even though Beta is not ISO 14001-certified or seeking certification, it turned to the standard for assistance in developing its EMS because of the legitimacy ISO 14001 has among businesses and regulators. Beta found, however, that ISO 14001 was difficult to apply to its operations.

Beta believes that this difficulty stemmed from the standard's focus, which is at the facility level, and thus most applicable to manufacturing entities that produce a single type of "product." Beta Municipality, however, is a large organization that creates numerous, diverse "goods" for public consumption, with customers who are taxpayers rather than discriminating consumers. For this reason, Beta's managers argue that public sector operations will likely have more difficulty implementing ISO 14001 than will other types of businesses.

A final and very important hurdle for Beta to overcome became apparent when its divisions began to design and implement the EMS. The specialized language of the ISO 14001 standard (e.g., aspects, impacts, significance, objectives, and targets) and EMSs in general were difficult for its division employees to understand. The result was several unproductive training sessions where much time was absorbed in defining EMS-related terminology and allaying employee anxiety. To overcome this hurdle, Beta had to revise its initial training tools so that technical jargon was removed and replaced with more familiar language and practical examples.

While Beta says that its EMS adoption process was difficult at times, like Alpha, it asserts that the benefits of its implementation were worth the investment. One benefit is that Beta's EMS has enabled the municipality to better evaluate its internal operating processes. As part of its EMS design process, for example, Beta recognized inefficiencies associated with its wastewater discharge process. This

evaluation has helped its management understand that the municipality's wastewater and other environmental impacts can be reduced further.

A second benefit of Beta's EMS is that the municipality better understands the high cost associated with its non-regulated impacts. By minimizing these impacts, through activities such as decreasing paper usage and emphasizing employee recycling, Beta expects that, in the future, it will more efficiently allocate taxpayers' revenue. For example, as part of its EMS, Beta recently evaluated its copier and printer leasing contracts and discovered areas where additional improvement can be made, especially in its supplier selection. The municipality decided to use only suppliers who can provide equipment that minimizes inputs and their related waste production.

A final benefit that Beta hopes to reap, in time, is shifting the municipality beyond a compliance-oriented mode of operation. Doing so will make its environmental strategy more consistent with its proactive risk management policy. Beta hopes that this management shift will also result in better relationships with its stakeholders and with federal and state regulators—which, as noted earlier, have been strained at times in the past.

## **CONCLUSION**

Time will tell whether Alpha Manufacturing's and Beta Municipality's EMSs are able to achieve all the goals the entities have articulated. Interestingly, several implementation hurdles and benefits were common to both organizations. Such results are contrary to conventional thought because the organizations are so very different from one another—Alpha is a small manufacturing company that produces goods for sale, whereas Beta is a large municipality that produces goods for public consumption. Both organizations, however, had difficulty navigating the ISO 14001 standard and gaining mid-level

managerial support for EMS adoption. The difficulty of translating the ISO 14001 standard into action was likely related to the newness for both facilities of integrating environmental considerations into their management structures. It is this newness that also likely affected managerial support (or lack of it) for adopting an EMS.

Even with all their hurdles, however, both organizations believe that adopting an EMS was a wise decision. While it is still too early to determine whether their environmental performance has improved, one unexpected outcome for these facilities—and for other companies in the pilot program—is the benefit of the EMS design process itself. This process (especially the assessment of environmental aspects and impacts and the determination of their significance), while arduous, has created a fuller and more widespread employee understanding of the facilities' impact on the natural environment. It has also bolstered employee involvement in the environmental issues that affect their work and increased employee morale. These benefits, while difficult to quantify, can significantly affect facilities' operations.

Finally, all 19 facilities (including both Alpha and Beta) report that non-environ-

mental considerations, such as meeting customer demands, maintaining a competitive advantage, reducing costs, and improving public relations, influenced their decisions to adopt an EMS. While these results are preliminary, as additional data become available, we may find that businesses adopt EMSs for many other compelling reasons in addition to environmental improvement.

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## REFERENCES

- Klassen, R.D., & McLaughlin, C.P. (1996). The impact of environmental management on firm performance. *Management Science*, 72(3), 2–7.
- Kleiner, A. (1991, July/August). What does it mean to be green? *Harvard Business Review*, 39–47.
- Portney, P.R. (1993). *Public policies for environmental protection*. Washington, DC: Resources for the Future.
- U.S. Environmental Protection Agency. (1990). *Environmental investments: The cost of a clean environment*. Washington, DC: Government Printing Office.

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