Environmental Management Systems and ISO 14001 Certification for Construction Firms

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Abstract: Environmental management systems (EMSs) are intended to formalize procedures for managing and reducing environmental impacts. Construction firms typically do not have comprehensive and certified environmental management systems. This paper discusses the elements of environmental management systems, the relationship to the ISO 14001 standard, and the importance for construction firms to implement an EMS. A case study of a certified environmental management system for a construction firm is presented. Benefits and costs of such systems are identified. The paper concludes that construction firms should begin to work towards implementing more complete environmental management systems, although fully certified systems are not essential.

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Introduction

Construction projects pose enormous challenges to not only finish within an owner's schedule and budget, but to also eliminate and minimize harmful impacts to the environment. Construction has significant impacts on the natural environment (Hendrickson and Horvath 2000). Even a minor impact, such as a small release or spill of a hazardous substance, can cause a health or environmental threat and lead to costly cleanup activities. In many instances, a company's impact can be attributed to the lack of an adequate environmental management system (EMS). An increasing number of construction firms are becoming certified to international standards worldwide, especially the International Organization for Standardization (ISO) 14001 series, which provide guidelines for implementing an EMS.

The first ISO 14001 standards were published in 1996, thus aside from articles in trade publications, little research regarding its implementation in the construction industry has been published in professional journals.

In this paper, we discuss environmental management systems and the ISO 14001 standard in particular. We summarize experience and literature on construction EMSs, including a case study of an ISO 14001 certified construction firm. Our intent is to summarize the necessary elements of an EMS, the potential benefits and costs, and the importance for construction firms to implement such systems.

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Characteristics of Environmental Management System

An EMS is used to address an organization's impact on the environment. Organizations implement such systems to maintain compliance with environmental regulations, lower environmental costs, reduce risks, train employees, develop indicators of impact, and improve environmental performance. An EMS typically consists of policies, goals, information systems, task lists, data collection and organization, emergency plans, audits, regulatory requirements, and annual reports (Ilnitch et al. 1998; Stapleton et al. 2001). In general, an EMS should be based upon an organization's documented environmental policy and contain the following characteristics:

1. Goals, methods, and a timeline for meeting environmental requirements and voluntary undertakings;
2. Procedures for maintaining appropriate documentation relating to its goals;
3. A defined structure and the responsibilities for each task along with the availability of adequate resources;
4. Corrective and preventative actions as well as emergency procedures;
5. An employee training plan with periodic updates to define goals of the EMS, responsibilities, and risks; and
6. A plan for periodic auditing of the organization's performance in achieving the goals and how well the EMS helps the organization to achieve those goals (Cascio 1996; Matthews 2001). Environmental performance metrics are needed to measure improvement with respect to environmental goals. Such parameters are essential to support goal setting, monitoring, and continuous improvement in product design (Fiksel 1996).

Few construction firms have implemented a full EMS system. Such systems are most common among manufacturing facilities, which have relative stability over time and a longer and more extensive history of environmental regulation.

Companies that are proactive in implementing an effective EMS seek multiple benefits:

- Improved regulatory compliance requirements;
- Open markets and reduced trade barriers;
- Reduction in liability and risks;

- Enhanced credibility among customers and peers;
- Reduction of harmful impacts to the environment;
- Prevention/reduction of pollution and waste, many times resulting in cost savings;
- Improvements in site and project safety by minimizing injuries related to environmental spills, releases, and emissions;
- Improved relationships with stakeholders such as government agencies, community groups, and investors; and
- Establishment of a system for continued environmental improvement.

There are also significant resource requirements for an EMS, especially management and worker time in developing plans, documenting the EMS, undertaking training, accomplishing EMS tasks and undergoing environmental audits (Kloepfer 1997; Hull 1998; Krizan 1999).

Griffith (2000) suggested that construction firms go beyond implementing an EMS. He noted that operating separate quality, environmental, and health and safety management programs lead to redundancy of tasks and information collection. He suggested that an integrated management system that streamlines the policies, documentation, data collection, and auditing of quality, environmental, and health and safety management systems will help to share information, save time, and improve risk assessment. A notable example of possible integration is the ISO 14001 EMS standard, which resembles the ISO 9000 quality management standard in many ways. Shen and Walker (2001) discussed how utilizing an integrated EMS, health, safety, and quality management system improved planning. By involving key personnel early on a project, the integrated system helped to identify risks earlier and helped to lead to a timely construction project.

ISO 14001 Environmental Management System Standard

The ISO 14001 serves as the standard for developing an EMS in the International Organization of Standardization's ISO 14000 series. The remaining standards contain guidance and supporting documentation. Table 1 outlines each standard in the ISO 14000 series.

The ISO 14001 standard defines an EMS as ''a management tool enabling an organization of any size or type to control the impact of its activities, products or services on the environment'' (ISO 2002). The ISO 14001 establishes a framework for managing (through the development of formal processes and procedures) the environmental aspects of an organization. The standard contains 17 key elements grouped into five major areas: environmental policy, planning, implementation and operation, checking and corrective action, and management review. A unique aspect of the system is that it is designed to be appropriate for any company, regardless of industry, size, location, and the level of their environmental responsibilities. The ISO 14001 is a voluntary, consensus-based, and market-driven standard (Kloepfer 1997).

Firms that pursue ISO 14001 certification must conform to the various requirements of the standard and undergo an external review. The ISO 14001 does not require any environmental performance metrics or absolute requirements other than: (1) committing to comply with applicable legislation and regulations and (2) implementing a continual improvement process (ISO 1996). Many firms go beyond the ISO 14001 EMS requirements by adding additional elements for goal setting and public reporting of emissions beyond legal requirements. For these firms, ISO 14001 is viewed as necessary, but not sufficient, for effective environmental management (Matthews 2001). It is also possible to adopt some or all elements of the ISO 14001 standard without becoming certified.

Table 1. Summary of ISO 14000 Series Standards (Source: ISO 2002)

Standard No.	Title
14000	Guide to Environmental Management Principles, Systems, and Supporting Techniques
14001	Environmental Management Systems: Specification with Guidance for Use
14004	Guidelines on the Elements of an Environmental Management System
14010	Guidelines for Environmental Auditing: General Principles of Environmental Auditing
14011	Guidelines for Environmental Auditing: Audit Procedures—Part 1: Auditing of Environmental Management Systems
14012	Guidelines for Environmental Auditing: Qualification Criteria for Environmental Auditors
14013/15	Guidelines for Environmental Auditing: Audit Programmers, Reviews, and Assessments
14020/23	Environmental Labeling
14024	Environmental Labeling: Practitioner Programs—Guiding Principles, Practices, and Certification Procedures of Multiple Criteria Programs
14031/32	Guidelines on Environmental Performance Evaluation
14040/43	Life Cycle Assessment General Principles and Practices
14050	Glossary
14060	Guide for the Inclusion of Environmental Aspects in Product Standards

Information on ISO 14001 and EMS implementation is available through internet sources including sites run by ISO (ISO 2002), state websites [examples include Pennsylvania Department of Environmental Production (PA DEP 2002); North Carolina Division of Pollution Prevention and Environmental Assistance (NC DPPEA 2002)]; and the Environmental Protection Agency (EPA 2002b)]. These sources provide information on implementation plans as well as sector specific information and recent articles on EMSs.

ISO 14001 Environmental Management System in Construction

Although the topic of environmental management systems is fairly new to the construction industry, recent literature supports the need for construction firms to consider developing and implementing such systems.

There are over 36,000 organizations in 112 countries that have received ISO 14001 certification (ISO 2001). Japan is leading the world with over 8,000 certifications (see Fig. 1). The United States has less than 5% of all certifications and is well behind other developed countries with only 1,645 certifications. Updated information shows the U.S. continues to lag behind (Tóth 2002).

Compared to other countries, the U.S. construction industry is far behind. Countries including Hong Kong, Australia, and the United Kingdom have many firms undertaking the certification process (New South Wales Government 1998; Uren and Griffiths 2000; Tse 2001; Tam et al. 2002). For example, Pun et al. (2001) noted that while adopting ISO 14001 EMSs, the construction in-

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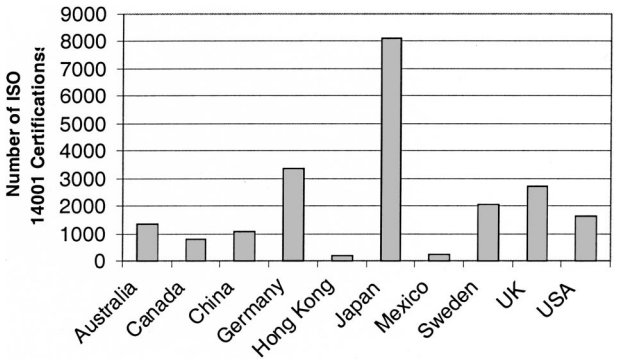

Fig. 1. Comparison of ISO 14001 certifications by country [source: ISO survey of ISO 9000 and ISO 14000 certificates: eleventh cycle (December 2001)]

dustry in the public housing sector of Hong Kong found that each project could benefit from an environmental assessment, a ''green manager,'' and a method for measuring performance.

As a precursor to the 1996 ISO 14001 publication, Powers (1995) discussed the importance of establishing ''a uniform approach to environmental protection'' toward developing a ''global ecocitizenship.'' The writer also noted the phrase ''green passport'' to define how a firm's acceptance of the ISO 14000 standards might provide them opportunities to do business multinationally. Powers concluded that regardless whether the U.S. EPA includes ISO 14001 into their policies and procedures, ''many companies will adopt it anyway, much like what has happened with the already well-accepted ISO 9000 quality standards.''

Kloepfer (1997) discussed the need for ISO 14001 by suggesting that a company ask itself a number of questions, all of which yield an answer of ''maybe.''

- Will it be difficult to implement, or will it save your company money?
- Do your customers care if the company pursues it?
- Does it address regulatory compliance?
- Will you need an outside consultant?
- Will it be compatible with your existing environmental management systems and company culture?
- Will it affect your company's ability to stay in business?

He concluded that companies need to weigh their business' environmental compliance objectives and determine ''what the real ISO 14001 is for them and to appropriately incorporate this standard into their 21st century environmental management strategy.''

Although their study focused on the ISO 9000 series of quality standards, results of the research by Yates and Aniftos (1997) can be extrapolated to ISO 14000 standards. The writers used a survey questionnaire that asked contractors for information on their company, knowledge and use of international standards, and the ISO 9000 series of standards. Based on their results, they developed a number of conclusions on international standards:

1. The U.S. construction industry recognizes that international safety, environmental, and social issues will affect competitiveness.
2. To ensure global market share in the long term, U.S. firms should use international standards.
3. Of those surveyed, 100% believe international standards are important; however, less than 50% have a strategy for involvement and less than 50% will sacrifice variety for standardization.
4. There is a significant lack of understanding regarding the enforcement of international standards.
5. Firms recognize that savings are possible by utilizing international standards versus internal standards.
6. Most of the survey participants felt they understood international standards, but they really only had knowledge of ISO 9000. This conclusion is understandable given that ISO 14000 standards were first published in 1996 (compared to Yates and Aniftos' study in 1997).
7. The current standards are fragmented and require more focus.

Yates and Aniftos (1997) noted, ''The United States has limited representation in the international community for standardization.'' In addition, they argued, ''if the United States does not increase its effort to counter, the international competitiveness of U.S. construction will be negatively impacted.''

Valdez and Chini (2002) identified key benefits of implementing ISO 14001 in the U.S. construction industry as improving public image, improving relations with regulators, and providing a competitive advantage. Their case study provided examples of benefits such as cost savings through process improvements.

In a study of 26 construction firms in Hong Kong, Tse (2001) identified the major benefits and problems associated with implementing an ISO 14001 EMS. The benefits to the construction firms included monetary savings (from energy efficiency and waste minimization), competition encouragement (by providing a means to differentiate services), occupational health improvement (by tracking and following appropriate environmental and health laws), lower insurance costs, and involving upper management in environmental decisions. The major obstacles included a lack of government pressure, lack of client requirement or support, expensive implementation costs, and subcontracting systems which create difficulties in managing the EMS.

Another limitation for construction firms to establish EMSs is their size. Without the upper management support and decision to mandate a company-wide EMS, environmental personnel may not have the resources to establish and maintain an ISO 14001 EMS. Industry groups such as the United Kingdom's Construction Industry Research and Information Association (CIRIA) provide guidance documents (Uren and Griffiths 2000) and workshops on implementing an ISO 14001 EMS within the construction industry (CIRIA Conferences EMS 2002). The average cost of project could be used to determine if a firm should implement an ISO 14001 EMS. In New South Wales, Australia, all construction projects must contain a basic EMS to identify and manage aspects and involve subcontractors. Major projects, ones having an estimated cost of over $5.5 million (U.S) must have a more elaborate EMS which would also include assigned responsibilities, monitoring requirements, emergency plans, and auditing procedures (New South Wales Government 1998). A measure of a construction firm's environmental impact whether it is based on number of jobsites, number of employees, total profits, or number of environmental requirements per jobsite should help a construction firm to determine how to implement an EMS and if pursuing ISO 14001 certification is worthwhile.

Elements of ISO 14001 Environmental Management System for Construction Firm

The ISO 14001 elements of an EMS include environmental policy, planning, implementation and operation, checking and corrective action, and management review (ISO 1996). We comment upon these requirements for construction firms below.

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Develop Complete Company Environmental Policy

The EMS starts with the company's environmental policy, or ''environmental mission statement.'' It is imperative that the policy be appropriate to the nature and scale of operations and encompasses all aspects of a company's operations. Aside from addressing legal requirements and regulatory compliance, the policy should show a commitment toward continual improvement.

Plan Must Conform to Company's Environmental Policy

In accordance with the environmental policy, the EMS must identify formal documented goals and objectives relevant to a company's environmental, legal, and regulatory requirements. The construction firm must make certain that the EMS assigns actions/responsibilities for specific tasks, sets targets to measure progress, and establishes completion dates. For example, the plan might identify environmental issues and select among possible mitigation responses as shown in Table 2.

Implementation and Operation of Environmental Management System Must Be Well Documented

This step defines all the processes and procedures (in other words, the well-established modes of control) that ensure success during implementation and operation. A key aspect is to define the roles of all individuals whose job could affect implementation of the EMS. Typically, two key elements in this step are well-defined training programs and an effective document control system.

Company Must Monitor and Measure Effectiveness through Checking and Corrective Action

After implementation of the EMS, monitoring and continuous improvement in processes are required to ensure that the system is performing as intended. Some of the key elements to ensure success of this step might include:

- Maintenance and calibration of equipment and procedures;
- Performance of EMS audits to ensure compliance by all individuals affected;
- Maintenance of records of all checking and corrective action procedures; and
- Developing requirements to track nonconformities.

Once the system is developed and in full-operation, the key to future success is continual improvement. As changes occur in a contractor's service and product, along with changes in environmental regulations, a contractor's EMS must also change.

Environmental Management System Review by Top Management is Imperative

Commitment by top management is essential to guarantee the credibility and effectiveness of a company's EMS. Regardless of changes or audit results, top management must review (at least annually) the need for changes to the policy, objectives, and procedures. The dynamics of a business institute constantly change. This change then creates a need for top management review of the EMS, to ensure continuing suitability, adequacy, and effectiveness.

This traditional Deming plan-do-check-act cycle was developed into a framework for implementing ISO 14001 in the construction industry by Zhang et al. (2000). The framework could be a mechanism to connect the process of construction to sustainable development (Zhang et al. 2000).

Case Study Method

Using a case study approach, we investigated how companies use EMSs to collect data and to inform company decisions. Nine U.S. companies with different types of EMSs participated. For each company, one representative facility was examined. Each case study consisted of an initial conversation detailing the project and verifying a company's willingness and interest in participating, research on publicly available environmental information, an exchange of information on the companies EMS or environmental programs, a site visit with a tour of the facility, a structured survey, a set of open-ended questions, additional questions that arose during the visit, and then followup contacts to fill in data gaps and verify information.

The case studies were used to understand how a facility uses an EMS to manage wastes, emissions, resources, and energy. We were able to identify the major components of the EMS, what types of information systems were used, the data used by the company, and the value of the EMS. Facilities were selected from a variety of industry sectors in the United States. Selection of cases was not random as this could cause collection of useless information and holes in the data set (Eisenhardt 1989). Instead, these facilities were usually manufacturing facilities, which are subject to many environmental regulations as well as many environmental challenges. Information that was collected and used at these facilities is likely to be similar to data used at other facilities. Additionally, problems encountered and decisions that must be made are likely to be similar to those at other facilities.

Each company's website provides publicly available information on their environmental programs. Other information that is available includes toxic release inventory data, Occupational Safety and Health Administration statistics, and documentation on programs such as National Environmental Performance Track (NEPT). The information exchanged by the company on their EMS or environmental programs ranged from entire EMS manuals to corporate presentations. A survey was developed to categorize the types of environmental data as well as how these data were collected, stored, used, shared, reported, and analyzed from the EMS and other sources. This helped to understand who has access to information and who is responsible for various tasks including entering data and maintaining the databases. The data helped to identify the EMS attributes that are useful and necessary for decision making. Appropriate techniques for survey design were used to generate a thorough and unbiased survey (Fowler 1993; Dillman 2000). The finalized survey consisted of 57 questions in five sections: Company and Facility Information; Environment, Health, and Safety Information Systems; Voluntary Initiatives; Environmental Management Systems; and General Questions (Christini 2003).

Case Study of Construction Firm

In addition to the eight traditional manufacturing companies, one construction firm (Beers Skanska, a subsidiary of the Swedish firm Skanska) participated in our project (Beers Skanska 2002). Although similarities existed across industries, there were some unique aspects of a construction firm's EMS.

In July of 1999, Beers Skanska became the first construction firm in the United States to achieve ISO 14001 certification. They

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Table 2. Potential Methods to Mitigate Environmental Impacts from Construction

Environmental impact	Potential mitigation methods
Stormwater runoff and erosion control	• Sediment basins • Vegetated stream buffers • Porous concrete (to reduce pollutant and water loads being transmitted to downgradient receptors) • Bioretention (use of sand filters in landscaped areas to pond runoff, then percolate it through the soil) • Addition of meanders to straight channels/streams to negate erosion
Diesel emissions	• Catalyst-based particulate filters on engine exhaust • Alternate fuel sources such as natural gas, fuel cells, and electric power • Cleaner burning diesel technology (that is less polluting), focusing on new fuel mixes • Ban morning operation of non-road diesel construction equipment (the intent is to delay diesel emissions of nitrogen oxide to limit its reaction with sunlight, to form ozone)
Dust and particulate emissions	• Installation of windbreaks • Lowering speed limits on haul roads • Re-sequencing or phasing construction activities to impact smaller portions of the site • Watering, especially in the early morning to minimize evaporation
Noise	• Eliminate or minimize the source • Provide shielding such as noise barriers, material stockpiles, fill embankments, and existing mounds in site terrain • Better engineering controls on equipment (rent and/or buy quieter equipment)
Construction waste	• Better planning by the contractor's purchasing agent to but only necessary material • Return or resell • Proper storage • Reuse • Recycle • Incinerate • Placement in approved landfills
Mass wasting, subsidence, and geomorphologic changes	• Perform proper due diligence prior to construction • Use geopiers for slope stabilization (a technique whereby pounded aggregate prestresses the surrounding soil and forms a bulb, subsequent layers of aggregate are compacted to form a stiff shaft) • Use of trenchless construction methods (for example, horizontal drilling) for underground infrastructure • Minimize site dewatering activities

are one of three Skanska firms (Beacon, Beers, and Sordoni) participating in the EPA's NEPT. The NEPT is a program established to recognize and motivate environmental leaders. By publishing the environmental goals set through their EMS, companies are held accountable to work to improve their environmental performance (EPA 2002a).

Beers Skanska utilizes an EMS that follows the framework outlined in the previous sections. Their environmental policy encompasses the following seven areas:

1. Regulatory compliance,
2. Prevention of pollution,
3. Conservation,
4. Emissions and effluents,
5. Ecology and habitat,
6. Hazardous and toxic substances, and
7. Communication.

The Beers Skanska EMS, which was developed with the intent of becoming ISO 14001 certified, outlines a plan consistent with the policy. Outside consultants were involved in the 2 year $1 million process of developing goals, documenting activities and practices, and training employees on the EMS (E. P. Hatch, personal communication, August 2, 2002). Goals are evaluated on an ongoing basis and revised pending feedback from biannual ISO 14001 registration audits. Examples of goals are listed as part of the Beers Skanska's participation in NEPT (Spivey-Tilson 2002):

1. ''Reduce solid waste by 30% through reducing material use and through recycling and reusing materials on-site;
2. Reduce energy use by increasing by 10% the number of projects per year that focus on energy reduction;
3. Reduce air emissions by increasing by 5% the number of projects per year that focus on air emissions; and
4. Further reduce air emissions by 30% through continuing to encourage alternative commuting methods for employees.''

The development of a company-wide EMS is really just the first step for a construction firm. Beyond the company-wide policies, each of the 200 jobsites at Beers Skanska must use the company plan to establish a project EMS and identify significant environmental impact aspects. Areas such as erosion control, hazardous materials and waste, air emissions, energy conservation, and water conservation are considered to determine which aspects are significant. All employees on a jobsite go through EMS training at the beginning of each project, and workers carry a pocket card with information of the environmental policy and the significant aspects. Each jobsite sets goals and collects data to measure performance towards these goals. Beers Skanska utilizes a web-based information system throughout the EMS process to help select aspects, collect and track data, and submit biannual reports on environmental performance.

In the case study survey, the Beers Skanska EMS provided the most value with improved environmental impact, performance enhancement of processes, and managing regulatory requirements (E. P. Hatch, personal communication, August 2, 2002). In addition, financial savings have been documented such as the diversion of 50,000 yd^3 of waste from landfills as a result of the EMS, which saved over $400,000 (Spivey-Tilson 2002).

Discussion

In a study on EMSs in construction firms in Hong Kong, Tse (2001) found that the major obstacles for implementing ISO 14001 standards were: lack of government pressure, lack of client requirements or support, expensive implementation costs, and in-

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compatible subcontracting systems. Beers Skanska implemented its ISO 14001 EMS without government or client pressure. Instead, they chose to fulfill Skanska's environmental commitment and gain a competitive edge. Although Beers Skanska does not require subcontractors to have their own EMS, they must participate in implementing Beers Skanska's EMS at the jobsite. The quality and quantity (about 200 projects at a time throughout the United States) of projects motivates Beers Skanska's subcontractors to meet their demands. This development of separate EMSs aligns with Zhang et al. (2000) and Pun et al. (2001) ideas for a framework for EMSs in the construction industry.

Although Beers Skanska is currently operating an ISO 14001 certified environmental management system, they are considering integrating the environmental and health and safety divisions. This could lead to the integration of management systems suggested by Griffith (2000) and combine tasks such as daily audits of the jobsite. Membership in the NEPT program has moved them beyond the minimal ISO 14001 requirements to setting publicly available goals for environmental improvement.

A properly implemented EMS will help to control environmental impact, improve environmental performance, improve training, improve communication, and improve data collection. There is also the potential for an EMS to save money through process change or product selection. Additionally, an EMS could help to reduce risks. One method for helping to quantify risks was presented by Chen et al. (2000) in which a construction pollution index (CPI) to determine the level of pollution or hazards caused by urban construction projects. The writers concluded that their CPI is vital to build environmental management into construction management by obtaining ISO 14001 certification. The ISO 14001 EMS process requires each project to identify and work to comply with all federal, state, and local requirements. Mitigation of some risk may help to reduce insurance costs (Tse 2001).

Beers Skanska believes that ISO 14001 certification helps to change the behavior of a company by making environmental management an important part of every project (E. P. Hatch, personal communication, August 2, 2002). The certification process and frequent audits force employees to be continually educated. If a firm implements an EMS, but does not go through frequent third-party audits, there is not the pressure to maintain the EMS and continually make improvements.

Currently, ISO 14001 certification gives Beers Skanska a competitive advantage. Clients acknowledge their well-established and well-implemented environmental management at jobsites. For example, religious organizations and community groups have requested sustainable building options, which can be implemented within the framework of their EMS (Quinn 2000). Although projects are not won because of the EMS, Beers Skanska has often been asked to submit bids based on their reputation (E. P. Hatch, personal communication, August 2, 2002). Clients interested in Green Building Certifications such as *LEED* [United States Green Business Council (USGBC) 2002] also want to ensure that the contractor does ''green'' work. Additionally, some clients may soon begin requiring contractors to have an EMS in place.

The ISO 14001 certification is easier in sectors where other firms are also certifying. Companies can learn from each other, consultants are able to provide guidance, and suppliers and customers can get involved in the process (Delmas 2001). In our case study, some facilities noted they met with industry peers to discuss similar environmental challenges while others looked at all challenges independently (Christini 2003). Although Skanska is one of the few U.S. construction firms to become certified, their subsidiaries are able to benefit from each other. Annual meetings between Skanska environmental managers allow them to share ideas and solutions (E. P. Hatch, personal communication, August 2, 2002).

One of the biggest challenges is monitoring environmental performance over time. In the construction industry, each project is unique with new challenges and problems. Therefore, a year-to-year comparison of waste recycled, air emissions, or fuel usage cannot easily be normalized. The meetings between Skanska firms allow individuals to discuss this type of obstacle and share tools for collecting and managing data. In Hong Kong, ISO 14001 construction firms have been slow to adopt environmental performance evaluation (EPE or ISO 14031) due to ''lack of technological support, such as training, staff, and expertise'' and ''increase in administrative costs'' (Tam et al. 2002). In the survey by Tam et al. (2002), construction firms identified that using EPE would help to ''establish standards for the management process'' and ''highlight environmentally friendly techniques.''

Currently, few U.S. competitors are embracing the idea ISO 14001 certification. ''Skanska welcomes such a trend at other companies in the construction and project development industry, since it would create more active environmental work in the industry and more effective collaboration with both clients and suppliers'' (Skanska 2002a,b).

Conclusions

Although Beers Skanska's ISO 14001 registration is still rare in the U.S. construction industry, EMS development and implementation is gaining momentum among contractors. Specifically, ISO 14001 serves as the primary model for a contractor's EMS. Our key conclusions are outlined below.

1. Construction firms are realizing that environmental management is a primary key to their success. They understand that it is imperative to eliminate or minimize harmful environmental impacts from construction.
2. EMS programs should be developed and implemented with defined goals and commitments.
3. ISO 14001 allows construction firms to determine what EMS level is right for their organization, so they can maintain an even balance between costs and benefits.
4. ISO 14001 does not state specific environmental performance criteria or metrics to achieve. Therefore, opportunities for future research might focus on developing a set of ISO 14001 metrics, and analyzing their application to various types of construction contractors.
5. Programs such as EPA's National Environmental Performance Track (NEPT) help to communicate to the public about environmental performance by providing information about goals and annual progress. NEPT requires an EMS, but not necessarily ISO 14001 certification.
6. A construction firm's size limits its ability to establish an EMS.
7. A measure of a construction firm's environmental impact, whether it is based on number of jobsites, number of employees, total profits, or number of environmental requirements per jobsite, should help a construction firm to determine how to implement an EMS and if pursuing ISO 14001 certification is worthwhile.

While outside pressures are not yet forcing certification in the U.S., ISO 14001 certified firms will continue to improve their EMS (as is required). As requests from clients for EMSs or ''green'' contractors increase, certified firms may pull ahead of

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their competition. As workers and subcontractors become used to recognizing environmental problems and working to solve them—the ideas of environmental management may spread to other firms. Moving towards more complete EMSs in individual firms is likely to be a good strategy, even if ISO 14001 certification is not obtained.

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