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ISO 14000: Its relevance to the construction industry of Singapore and its potential as the next industry milestone

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ISO 14000 is a series of standards defining a formal and structured approach to environmental management. It demonstrates, with assurance, that an organization which complies with current policy and legislation actively addresses environmental issues. Construction activities have a myriad of environmental implications. Hence, construction entities must manage their environmental performance. ISO 14000 represents a possible solution. This study considers the relevance of environmental management to construction organizations. After an overview of the environmental impacts of construction, ISO 14000 and its principles are explored. A field study is reported that was set up to assess the level of commitment of construction enterprises in Singapore to environmental management. Contractors in Singapore are aware of the merits of environmental management, but are not instituting systems towards achieving it. A framework for the development and implementation of an environmental management system (EMS) is proposed.

Keywords: Construction industry, environmental management, ISO 14000, implementation, Singapore

Introduction: emergence of a new order

The ISO 14000 series emerged as a result of the Uruguay round of the General Agreement on Tariffs and Trade (GATT) negotiations and the 1992 Rio de Janeiro summit on the environment. Also in 1992, the British Standards Institution (BSI, 1994) introduced BS7750, the world's first environmental management standard. In 1993, the European Union (EU) launched its version, the Eco-management and Audit Scheme (EMAS) (Quality Network, 1996c). Other countries soon developed their own environmental management standards which were modelled after BS7750 (which was revised in 1994) and EMAS.

The International Organization for Standardization (ISO) established a Technical Committee, TC207, in 1993 to develop a set of unified, voluntary standards for environmental management, to be known as the ISO 14000 series (Quality Network, 1996a). The final version of the draft standards on an environmental management system (EMS) and environmental auditing was published in 1996. Countries which adopted the Draft ISO EMS standards (DIS) as their national standards include Austria, Australia, India, France, Japan, Malaysia, New Zealand, Switzerland, Singapore, Turkey and the USA. In 1996, Singapore became the second country in Asia (after Japan) to start certification to the ISO 14001 DIS (Tan, 1996, p. 37). The Regional Institute of Environmental Technology (RIET), set up by the government of Singapore and the European Union, *inter alia*, to promote and facilitate environmental businesses in Asia and to develop envronmental skills, has been the lead organization in Asia promoting the ISO 14000 Standards.

Constructors, in effect, modify the natural world to create facilities for human activities (Moavenzadeh, 1994, p. xvi), but have not recognized the environmental effects of their activities until recently

(UNCHS, 1990; Moavenzadeh, 1994, pp. 26–28). However, actions of pressure groups, expanding regulations and increasing client awareness are resulting in constraints on construction projects (Ofori, 1992; Foo *et al.*, 1995). Thus, construction practitioners must be aware of the role of construction in the environment, understand and comply with existing regulations, and prepare for the markets that will be created by stringent environmental requirements. The ISO 14001 DIS: *Environmental Management Systems – Specification with Guidance for Use* presents a blueprint for construction organizations to achieve this objective. Within the Standard, an organization of any size and nature of operations can develop its own policy, strategy, procedures and practices to implement an EMS (Rothery, 1995, pp. 35–43).

Research aim, objectives and scope

This study aims to evaluate the possibility of implementing the ISO 14000 series in the construction industry in Singapore. Its objectives are: first, to determine why construction companies should implement environmental management programmes; second, to study the principles of ISO 14000, its relevance to construction and the difficulties relating to its implementation; third, to ascertain the current level of environmental awareness and practices of the Singapore construction industry; and, finally, to propose a framework for implementing the ISO 14000 standards in a construction firm in Singapore.

The study seeks to propose a framework for an environmental management programme. Hence, it does not offer solutions to the causes of environmental degradation. It focuses on contracting organizations in Singapore.

Construction and the environment

Relationship between construction activity and the environment

There is a growing awareness of environmental issues and the likely problems from a deterioration of the environment (Brundtland, 1987; Brown *et al.*, 1996). However, much confusion, disagreement and uncertainty prevails (Miller, 1995; Ofori, 1998).

Ofori (1992), CIRIA (1993), UNCHS (1993) and Hill and Bowen (1997) provide comprehensive reviews of the effect of construction activities on the environment. These effects include land use and land deterioration, resource depletion, waste generation, and various forms of pollution (UNCHS, 1990; Ofori, 1992).

Many natural areas are irreversibly damaged by construction activities which alter their ecological integrity (Ofori, 1992, 1993). A major environmental impact of construction stems from its consumption of materials, many of which are non-renewable. Lenssen and Roodman (1995, p. 97) estimate that buildings account for about 40% of the materials entering the world's economy each year and for 25% of the world's usage of wood. Exploitation of forest resources (Worldwatch Institute, 1995, p. 14; Brown *et al.*, 1996) and quarrying (UNCHS, 1993) leave their mark on the environment. Site construction produces many atmospheric pollutants (UNCHS, 1990, 1993). Negligence on sites often results in the spillage of substances which are washed into water reservoirs. Large volumes of waste result from the production, transportation and use of materials (UNCHS, 1993). Large amounts of energy are consumed during the manufacture of materials, and in the use of completed items (Lenssen and Roodman, 1995). A building or structure has a long lasting effect on the populace and its environment (Bright, 1991).

Since construction has such a propensity to affect the environment adversely, it must take action to manage its environmental impacts.

Some past works on construction and environmental management

There is a large and growing body of literature on environmental management in construction. Briffett (1996) highlights the means by which the industry can achieve the objectives of ISO 14000, and recommends that environmental policies, objectives and targets be considered during each stage of the development project. Low (1996) examined the possibility of ensuring environmental protection through architectural design. From a survey of architects in Singapore, she concluded that the construction industry was not ready for an environmental management standard.

Samuels and Prasad (1994) discussed the interaction between the built and natural environments, and charted the developments and possible remedies in terms of social responsibility, environmental accountability, environmental and energy auditing, ecologically sustainable design, and energy standards and labelling. After reviewing the environmental consequences of construction operations, Ofori (1992) suggested that to develop a culture of environmental protection in construction, the client must adopt 'the environment' as a project objective. Moavenzadeh (1994) considered the potential for positive contributions by the construction industry in efforts to protect the environment, and identified relevant business opportunities. Griffith

(1994) outlined the concepts of environmental management and its importance in construction, proposing a framework for a structured environmental management programme in the construction industry, based on BS7750.

Hill and Bowen (1997) stressed the importance of EMS within construction organizations to guide construction, operation and decommissioning. They cited the example of the Shimizu Corporation's EMS, and offered an EMS framework for other construction companies (p. 234). They suggested that environmental management should be stated as a requirement in contract specifications and bills of quantities (p. 237). The Construction Industry Research and Information Association (CIRIA, 1994a, b) has prepared a series of handbooks to guide construction enterprises to adopt environmentally responsible practices. The handbooks seek (CIRIA, 1994b, p. v): (i) to provide a checklist for, and guidance on, environmental considerations at various stages of a construction project; (ii) to produce a framework for the identification of existing information and current good practice; and (iii) to provide a framework to assist construction companies to compile registers of environmental effects and adopt appropriate environmental management procedures.

ISO 14000: The new order

This section outlines the framework, principles and prescriptions of the ISO 14000 Standards and compares them with those of other environmental and quality management paradigms.

Nature of ISO 14000

An EMS is an organization's formal structure that implements environmental management. It is defined by clause 3.5 of ISO 14001 (ISO, 1996a) as: 'The part of the overall management system which includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy'.

The ISO 14000 series cover six areas: (i) environmental management systems; (ii) environmental auditing and related investigations; (iii) environmental labelling; (iv) environmental performance evaluation; (v) life-cycle assessment; and (vi) terms and definitions (ISO, 1996a,b,c).

The Standards are basically of two types: guidance and specification. All the Standards except ISO 14001 are guidance standards, which are descriptive documents, not prescriptive requirements. Companies *do not register* to ISO 14000 as a series; *they register to ISO 14001*, the specification that is a model for an EMS. ISO 14001 provides an objective understanding of the environmental aspects and impacts of the organization's activities (Tibor and Feldman, 1996). It enables objectives and targets defining the environmental goals to be set, and the path towards achieving them to be outlined. It also provides for internal audits of the EMS to ensure compliance and effectiveness, and periodic review of the system (ISO, 1996c).

Purposes and benefits

An organization may elect to comply with ISO 14001 in order to have a model for an EMS, a format to audit its EMS against or a method to determine the environmental effects of its business (Biggs and Nestel, 1996). Organizations should consider registration to ISO 14001 if it is a customer or industry requirement, complements their market strategy, or can be a motivational factor. Effective environmental management may be a prerequisite to the maintenance or the enhancement of the competitiveness, or even survival, of the organization.

Implementation of an ISO 14001 EMS offers several benefits (Quality Network, 1996d). First, it enhances the organization's image and credibility. Second, the organization can derive savings from resource conservation and waste minimization. Third, it helps the organization to comply with environmental legislation and regulations, reducing incidents that result in liability. Fourth, it helps reduce environmental risks. Fifth, it reduces costs associated with consumer audits. Finally, the organization can expand into markets where environmental management is a desirable or compulsory requirement (*The Straits Times*, 1995).

These potential benefits are relevant to construction companies which compete for single projects where track record, image and reputation are usually important considerations. The minimization of materials wastage translates directly into lower operating costs. Construction operations are governed by many regulations and codes; and the activities of construction companies are subject to numerous risks and uncertainties. The giant Swedish construction firm, Skanska (1998, p. 3), notes that, in its experience, an EMS improves environmental performance and increases employee commitment and understanding of the company's environmental impact. Reducing environmental impact is synonymous with ensuring optimal use of resources and saving money. Environmental audits relating to EMS lead to measures which improve competitiveness.

EMS and quality management system (QMS)

There are many similarities between the ISO 9000 series of quality management standards (QMS) and ISO 14000 (Rothery, 1995; ISO, 1996a). Both are management systems which require organizations to formulate policies, define roles and responsibilities, appoint a management representative and train personnel. Moreover, both require documentation, record keeping, internal audits and management reviews. There are also marked differences between the two systems. Whereas ISO 9000 stresses consistency, ISO 14000 is more demanding because it emphasizes continual improvement. Furthermore, ISO 9000 is market driven while ISO 14000 is driven by stakeholders, the community or regulators.

The similarities between the two management systems indicate the possibility of integrating them. Companies which have an ISO 9000 QMS will have less difficulty in implementing ISO 14000 as the management system 'template' is already present. Rothery (1995) analysed the main differences between ISO 9000 and ISO 14000 and offered an environmental management framework for ISO 14000 accreditation.

Ofori *et al.* (1996) discuss developments relating to quality considerations in the procurement of construction projects in Singapore. Since the late 1980s, contractors have been encouraged and assisted to attain a high quality of workmanship on projects, and to institute QMS in their organizations (CIDB, 1994). ISO 9000 certification will become a prequalification requirement for contractors and consultants of public sector projects valued at S$30 million and above (US$1.00 = S$1.68) by July 1999. It is reasonable to expect, as CIRIA (1994b, p. 6) notes, that developments with respect to EMS will be similar to those relating to a QMS, 'with some clients requiring any contractor wishing to tender to have established a certificated quality management system'.

Developments in Singapore

The environment in general

Singapore wishes to be a 'model environment city'. It has instituted measures including statutes, regulations, codes, incentives, taxes, charges, administrative systems and public education programmes to achieve this (Ofori, 1993, p. 52). Singapore's 'Green Plan' is based on principles including: satisfying economic needs; preventing pollution at source; conducting an environmental impact assessment for all development projects; educating the public; legislating and enforcing; and monitoring and reviewing (Ministry of the Environment, 1991). Ofori (1993) discusses environmental issues relating to construction in Singapore; and Ooi (1995) reviews Singapore's experience in enhancing its environment in its economic development.

The Ministry of the Environment (1993) summarizes statutes and regulations relating to environmental protection in Singapore, many of which relate to construction. These include the Clean Air (Prohibition on Use of Open Fires) Order 1973, which bans the hitherto common practice of burning waste materials on site; and the Environmental Public Health (Control of Noise from Construction Sites) Regulation, 1990 which specifies limits for noise emission. The Pollution Standard Index (PSI) of 50, introduced in 1995, has a bearing on the control of dust generated on the construction site. The government provides incentives and imposes charges and taxes to promote the conservation of energy and water, and minimization of waste.

Despite these developments, so far the construction industry in Singapore has not shown much commitment to issues relating to the environment (Ofori, 1993).

ISO 14000

The main body for ISO 14001 promotion and certification in Singapore is the Productivity and Standards Board (PSB). The certificate is valid for 3 years (PSB 1996b,c) and is subject to review every 6 months. As was done for ISO 9000, assistance and incentives are offered by the government to organizations, especially the smaller ones, to attain ISO 14001 certification (PSB, 1996a; Tan, 1996). In 1998, the PSB formed a support group among companies from all sectors interested in seeking ISO 14001 certification, to facilitate the sharing of ideas and experiences, the pooling of resources, and collaborative action.

Construction lags behind other sectors with regard to EMS implementation. Only one local contractor has attained ISO 14000 certification (in June 1998). At the time of writing, the Construction Industry Development Board (CIDB) did not have any plans to promote ISO 14000 in the industry, or to give greater emphasis to the merits of environmental management.

Developments in other countries

In many industrialized countries the construction market is changing. In the UK, CIRIA (1995, p. 6) advises clients to set up an environmental policy for each project and to consider implementing an EMS based on BS7750. They should include past environmental track record in their criteria for selecting designers, and in their procurement. The UK Department of Transport, Environment and the

Regions (DETR, 1998, p. 8) notes that 'environment management systems such as ISO 14001 are beginning to be adopted in construction', as far-sighted clients and construction enterprises recognize the business benefits of adopting a more sustainable approach. CIRIA (1994a, p. 139) urges clients' consultants, in preparing a select tender list, to consider: '. . . the extent to which the client wishes to restrict his or her choice of tenderer to those firms that have an environmental management system in place or can in some other way demonstrate their commitment to environmentally responsible operations'.

Many international construction companies have systematic EMSs. The NCC Group, the Scandinavian construction and real estate company, achieves its 'guiding principles for correct environmental behaviour' (NCC AB, 1998, p. 5) by: (i) basing its operations on a holistic life-cycle approach; (ii) minimizing the effects of its interventions on nature; (iii) involving all employees in environmental issues through leadership, training and dialogue; (iv) achieving or exceeding the requirements of laws, regulations and other environmental requirements; (v) using an EMS to direct and control operations; (vi) stimulating R&D; (vii) cooperating actively with customers; and (viii) reporting openly its environmental work. It has integrated environmental considerations into all operations, based on ISO 14001, and aims for certification by 2000.

Skanska, a large international construction company based in Sweden, which operates in some 50 countries, notes: 'Skanska's vision is to become the leading company in construction services and project and real estate development. This requires, among other things, that all of us at Skanska take environmental issues seriously.' (Skanska, 1998, p. 2). Skanska has accelerated the building up of EMS to achieve its environmental goals based on ISO 14001, with the hope of certification in 2000.

Field study

Nature and method

A field study was conducted in July–August 1996 to gauge the level of environmental awareness and practices in the construction industry in Singapore, and ascertain the industry's views on the implementation of the ISO 14000 standards. Interviews of officers of the Construction Industry Development Board (CIDB), the PSB, the Nature Society (Singapore), the National Council for the Environment, environmental consultants and the Singapore Association of Environmental Companies provided information on broad environmental issues in Singapore and on the ISO 14000 series, and helped in drafting a questionnaire.

The target group for the mailed questionnaire survey was construction companies which had attained ISO 9000 certification. This selection criterion was chosen because companies with ISO 9000 accreditation are the most likely to have, or to be interested in, environmental practices since, to achieve quality management, they must consider, *inter alia*, the environmental impacts of their operations. The questionnaire was designed to determine the current practices of construction firms in environmental protection, and their views on the implications for their operations and their companies, of the implementation of ISO 14001.

80 questionnaires were mailed to all companies in the list of PSB-CIDB ISO 9000 certified construction companies whose names appeared in an advertisement published by the CIDB (*The Straits Times*, 1996), and in the *Directory of SISIR Certified Products and Companies and Accredited Laboratories* (SISIR, 1995). These were all in the top three (out of eight) size categories. 182 companies were then registered in these three categories. Thus, the questionnaire was sent to about 30% of such firms. Of the 80 questionnaires mailed, 24 were completed and returned, giving a response rate of 30%.

In the analysis below, the collated raw percentages of responses to the questions are presented in most cases, as the intention is to indicate the level of environmental awareness and practice among contractors. The Hungarian method of assessment was used to determine the overall ranking among various issues or measures where relevant.

Survey findings

Respondents

All the construction firms which replied to the survey were registered by the CIDB in the highest financial category. Of the persons completing the questionnaire, 58% were directors, chief executive officers, general managers or assistant general managers; 29% were project managers, engineers or contracts managers; and 13% were quality assurance managers. All of the respondents asked for a copy of the survey findings, indicating that they were interested in issues relating to the ISO 14000 series.

The majority of the responding firms were ISO 9000 certified in 1995 (46%) and 1994 (38%). The rest of the companies were certified in 1996 (13%) and 1993 (3%). These results indicate that companies which were in the first year of their implementation of ISO 9000 were more interested in ISO 14000 issues.

Environmental policies

73% of the respondents indicated that normally they consider environmental issues in their corporate or project planning processes. Roughly half of the remaining 27% of the companies felt that environmental considerations were not relevant to their organization, while the other half either felt that it would not improve their company's competitiveness or that it offered little or no financial benefit. One responding company felt that it was the client's responsibility to take environmental considerations.

The responses of a significant proportion that environmental considerations were not relevant or beneficial are surprising considering the publicity given in Singapore to the merits of environmentally responsible commercial behaviour, the assistance schemes and incentives available, and the charges imposed for activities which have adverse environmental effects.

Priorities in project planning

Table 1 shows the order of priority accorded by responding firms to aspects of the construction project at the planning stage. Using the Hungarian method for assignment gives the overall ranking indicated in the last column which indicates that satisfying the client's specifications, and cost minimization were accorded the highest priorities by the construction enterprises. Evaluation of the project's impact on the environment ranked the lowest among the firms' project priorities.

The rankings accorded by respondents to their priorities when embarking on projects reflect the stress on cost as the main criterion in the award of contracts in Singapore. Deliberate efforts by construction firms to assess the environmental impact of their operations and act to address them are given the least priority, despite the respondents' declaration of their awareness of environmental issues and the importance of these in construction, and the claim of 73% of them that they consider environmental issues in their corporate or project planning processes.

Importance of environmental protection

All the respondents agreed that environmental protection is important to the construction industry. However, environmental protection was not the prime consideration in actual practice in any of the responding companies. The survey showed that the contractors take up environmental protection mainly to avoid infringing statutory regulations (40%), of which there are many in Singapore.

30% of respondents said environmental protection helps project a good image for a firm. However, the contractors weighted low the possibility of employing environmental protection as a means of satisfying the client's needs (10%) (which they had ranked as their top project priority in Table 1), to save costs (10%) (respondents' second most important priority in Table 1) or to be competitive (10%). Thus, it is clear that the contractors are unaware of the full potential of corporate environmental behaviour, and would be most likely to respond to mandatory requirements imposed by the government (through regulations), or by clients (through their procurement policies).

Environmental effects of construction

The questionnaire probed further the respondents' consideration of the environmental effects of construction by requesting them to indicate their views on the relevance of some environmental impacts of construction activity. The highest frequency obtained was for air pollution (46%), followed by illegal dumping of waste (25%), water pollution (18%) and noise pollution (11%).

These responses correlate closely with existing regulations in Singapore and, to some extent, the publicity given to their infringement by some contractors, and the action taken against them. For example, waste disposal charges have increased progressively and substantially in recent years; and illegal dumping is penalized.

Table 1 Ranking of project priorities when embarking on a project

	1st %	2nd %	3rd %	4th %	5th %	6th %	Total %	Ranking using Hungarian method
Minimize cost	27	27	20	20	0	6	100	2
Meet deadlines	20	27	33	7	7	6	100	3
Meet building regulations	20	7	7	40	20	6	100	4
Satisfy client's specifications	33	32	13	7	13	2	100	1
Reduce resource/energy wastage	0	7	27	20	40	6	100	5
Evaluate project's impact to the environment	0	0	0	6	20	74	100	6
Total %	100	100	100	100	100	100		

Environmental practices

Table 2 presents data on how the contractors ranked the various environmental practices common in Singapore's construction industry. Again, the top practices were those undertaken to comply with regulations. Among these practices are: 'keeping roads clean' (in order to satisfy a regulation against the soiling of public roads by mud and litter); and 'reducing noise'. Also prominent are actions to avoid or limit statutory charges, such as 'reducing usage of water', given the government's taxes on the consumption of this scarce resource in Singapore.

Contractors' responses concerning their actual environmental practices yielded the following ranking.

1. Keep public roads and drains clean (26%)
2. Conserve water by using less or saving water (20%)
3. Use environment-friendly materials (16%)
4. Cut down noise pollution (16%)
5. Reduce, reuse and recycle (15%)
6. Use lead-free fuel for machines and vehicles (5%)
7. Plant trees around the site (2%).

Comparing the overall ranking list in Table 2 with the summary of actual practices presented above indicates a close correlation between what is thought by contractors to be important and what they actually practise. Other environment-related measures taken by some of the respondents include the use of metal sheets in place of timber for temporary building works, active waste control, and use of equipment which produces less dust.

Awareness of ISO 14000

All the responding companies indicated that they had heard of, or read about, ISO 14000. This level of awareness of such a new standard was a surprise. Respondents learned about ISO 14000 from newspapers (37%), published papers (25%), magazines (19%) and conferences (19%).

Implementing ISO 14000 in the construction industry

Despite their recognition of the need for multilateral efforts in environmental protection, most (67%) respondents felt that the construction industry in Singapore is not ready for the implementation of environmental management standards such as the ISO 14000 series. However, 33% of them declared themselves ready to take on the environmental challenge. This contrasts with Low's (1996) finding that *all* of the architects she interviewed felt that the industry was not ready to implement environmental standards.

Top among the reasons given by respondents why the industry was not ready to adopt ISO 14000 were the lack of government support (23%) and the high cost of implementing an EMS (23%), while others included: practitioners' lack of understanding of the requirements of ISO 14000 (15%); lack of tangible benefits from EMS (15%); difficulty in assessing environmental costs (15%); and lack of insistence by clients on environmental requirements (9%).

Promoting ISO 14000

On the best way to promote the EMS standards, the largest proportion of the respondents felt that incentives should be given to ISO 14001 certified companies (32%). CIDB regulation to make it a requirement (21%) and government financial support (21%) were next cited, followed by campaigns to raise awareness (18%), and consultancy and training programmes (8%). Thus, the contractors supported the use of both 'economic' instruments (incentives) and 'command and control' measures (regulation and enforcement).

Table 2 Ranking of importance of various environmental practices

	1st %	2nd %	3rd %	4th %	5th %	6th %	7th %	Total %	Ranking using Hungarian method
Keep public roads and drains adjacent to site clean	29	14	7	29	7	0	14	100	1
Reduce, reuse and recycle	0	21	14	22	21	7	15	100	4
Conserve water by using less/saving water	36	8	14	14	7	21	0	100	2
Use materials/products which are environment friendly	7	21	15	21	29	7	0	100	5
Cut down noise pollution	7	21	29	0	22	21	0	100	3
Use lead-free fuel for machines/vehicles	21	8	14	0	14	29	14	100	6
Plant trees around site	0	7	7	14	0	15	57	100	7
Total %	100	100	100	100	100	100	100		

Joint certification

Given the similarities between the ISO 9000 and ISO 14000 series, respondents were asked for their views on joint certification to both systems. Slightly over half (53%) of the contractors supported the idea. The respondents seemed to believe that companies should first attain, and become familiar with, QMS certification before tackling the more demanding EMS certification.

Intention to obtain ISO 14000 certification

The final question related to the respondents' intention with respect to the ISO 14001 certification of their companies. 50% of them indicated that they would pursue ISO 14001 certification if it were a statutory prerequisite. 31% said they would seek certification even if it were not made mandatory. 13% of respondents indicated that they would not acquire certification while 6% expressed interest in certification but would seek it only if other companies did so.

This 'not me first' syndrome is typical among construction companies in Singapore which are conservative in most aspects except those which promise direct short term commercial benefit.

Discussion

The results from the survey revealed that the construction firms were aware of the impacts of their activities but were not environmentally proactive, save for compliance with regulations and meeting clients' specific requirements.

Whereas respondents showed an awareness of ISO 14000, few understand what the standards entail. Despite the PSB's efforts to publicize its potential benefits, respondents showed ignorance of the benefits, including possible cost savings and higher competitiveness. Although a majority felt that the industry was not ready for ISO 14000, a significant proportion of responding firms would implement it. However, many companies are waiting for external stimuli such as clients' insistence, market forces and statutory regulation before deciding whether to implement a structured EMS.

Environmental issues have not become a factor in competition among contractors in Singapore. A main survey finding was that contractors' top priority is to meet client's requirements. Thus, it would appear that the client should be the driving force of environmentally conscious construction (Ofori, 1992). A client organization's environmental commitment will filter down through the design and construction processes via the choice of consultants and contractors.

Environmental management is a team effort, and is achieved most effectively through the integration and balancing of the contributions of the participants in the many aspects of the construction process. A life-cycle approach should be adopted, from the extraction of raw materials and manufacturing, through transportation and storage of materials and components, to the demolition of the building and disposal of the waste. In the next section, a framework which construction companies can apply to implement an EMS is proposed. The framework is based on ISO 14004, the guide for implementing EMSs. Possible impediments to the implementation of an EMS in a contractor's organization, and how these may be overcome, are also discussed.

Framework for implementing ISO 14000

The process of establishing an EMS has five key principles (ISO 14004 DIS; ISO, 1996b). These are: (i) environmental policy; (ii) planning; (iii) implementation and operation; (iv) checking and corrective action; and (v) management review and continual improvement.

Environmental policy and planning

The first step in developing or improving an EMS is to obtain the commitment of the highest management levels of the organization (clause 4.1.2). The company's environmental policy sets the overall direction and principles of action (ISO, 1996b, clause 4.1.4). It sets the goal as to the level of environmental responsibility and performance required of the firm.

The company's current position with regard to the environment should be established in the initial environmental review (IER) (clause 4.1.3). The process and results of the review should be documented, identifying opportunities for EMS development. The requirements for an IER are: identification of legislative requirements; identification, evaluation and documentation of environmental aspects, significant impacts and liabilities; assessment of performance compared with relevant internal criteria, external standards, regulations and codes; existing environmental management practices and procedures; policies and procedures on procurement and contracting; feedback from investigation of previous incidents of non-compliance; and opportunities for competitive advantage.

The planning stage entails the identification of environmental aspects and evaluation of impacts, environmental policy, internal criteria, environmental objectives and targets, and environmental strategic plans and management programme (clause 4.2.1). The environmental effects should be documented

in the registry of environmental effects (Rothery, 1995, pp. 80–91). The list of legislation and regulations which relate directly to the firm's activities, products or services (clauses 4.2.3 and 4.2.4) should be documented in the registry of regulations (Rothery, 1995, pp. 56–66). Where external standards are nonexistent or inappropriate, internal performance criteria should be developed.

Indicators which quantify the objectives and targets forming the goals of environmental performance for the organization to attain (clause 4.2.5) must be established. To illustrate, assuming an objective of lowering the wastage of timber formwork, here is an example.

Objective:	Reduce wastage of timber formwork.
Target:	Achieve 20% reduction in level of timber usage on previous similar project.
Indicator:	Number of times which formwork can be reused.

To be most effective, the organization's environmental management programme (clause 4.2.6) should be incorporated into its long term strategic plan. It should be revised regularly to reflect changes in organizational objectives and targets.

Implementation

To ensure successful implementation of the environmental policy, the capabilities and support mechanisms in the organization must be identified (clause 4.3.1), and necessary resources made available. Table 3 illustrates how environmental responsibilities can be assigned in a construction firm. Owners of smaller firms have to be responsible for implementing the EMS.

The knowledge and skills necessary for the organization to achieve its environmental objectives should be identified (clause 4.3.2.5). Appropriate training should be provided to relevant personnel. Accurate reports and information (clauses 4.3.3.1 and 4.3.3.2) should be communicated to all staff, and other interested parties. All procedures and processes must be defined and documented in the 'environmental management manual'. All documentation should be reviewed periodically. Control procedures must be reviewed on different projects.

Monitoring and corrective action

The organization should measure, monitor and evaluate its EMS, with the objective of improving its environmental performance (clause 4.4.1). Actual performance should be measured against stated objectives, targets, legislation and regulations, and the results used to determine areas of success and to highlight necessary corrective action and improvement (clause 4.4.2).

The findings, conclusions and recommendations reached as a result of monitoring, audits and other reviews of the EMS must be documented and necessary corrective actions identified (clause 4.4.3). A systematic follow-up procedure should be adopted.

Table 3 Proposed environmental responsibilities of various members in a construction firm[a]

Roles and responsibilities	Establish overall direction	Develop environmental policy	Develop objectives, targets and programmes	Monitor overall EMS performance	Ensure continual improvement	Assure regulatory and EMS compliance	Identify clients', subcontractors' and suppliers' expectations	Comply with defined EMS procedures
Board of directors, CEO	●	●						●
Chief environment manager		●	●	●	●	●		●
General manager								
Chief project manager								
Other positions of authority								
Environment committee			●	●	●			●
Representatives from								
Project management								
Structural, M & E								
QS/Contract admin./								
Estimating								
Finance/Accounting								
Project manager			●		●	●	●	●
Structural M&E engineer			●		●	●	●	●
Contract manager/QS			●		●	●	●	●
Cost estimator			●		●			●
Finance/Accounting manager			●		●			●
All employees								●

[a] Compiled from ISO14004 DIS (ISO, 1996b) and Griffith (1994).

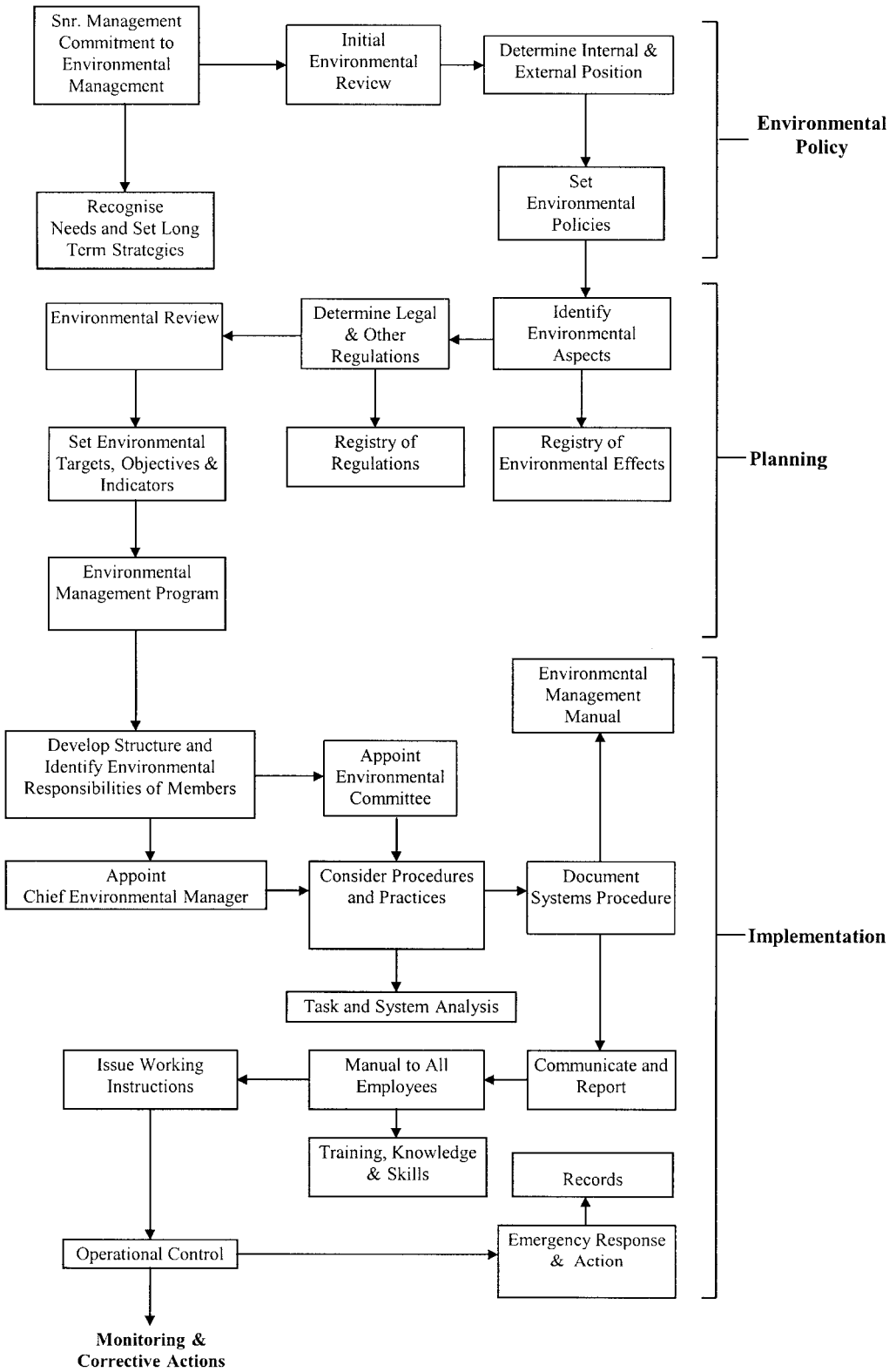

Figure 1 Systems diagram of ISO 14000 EMS process in environment policy, planning and implementation (compiled from ISO, 1996b)

Audits (by internal staff, external consultants or both) should be conducted periodically to determine whether the system conforms to planned arrangements and has been properly implemented and maintained (clause 4.4.5).

Management review and continual improvement

For an EMS to be effective it must be maintained and improved over time. Therefore, organizational commitment to the system must be long term. Management and personnel operating the system must aim for improvement. Linkages of the various stages and procedures are shown in Figures 1 and 2.

Barriers to adoption of ISO 14000 and their remedies

Four factors might hinder the adoption of ISO 14000 in a construction organization in Singapore. First, as the proposed framework shows, implementing an EMS is an elaborate, continuous series of activities which involves a revolution in the operations of the organization. For the ordinary construction company, the task will be onerous. Firms will require a major push to consider ISO 14000 certification seriously. Second, the financial burden of the implementation of an EMS is considerable (Griffith, 1994, p. 84). Thus, the financial assistance offered for such purposes in Singapore is most appropriate.

Third, some of the intricate environmental aspects of construction activities are difficult to assess and quantify. Finally, due to the diversity of construction activities and the uniqueness of each construction project, the environmental impacts and measures can be diverse. Thus, each firm must identify the unique blend of environmental cause and effect of its activities. External help would be required to identify these for the construction industry in Singapore as a whole, and for the typical construction firm, to provide guidance for contractors undertaking the IER for ISO 14001 certification.

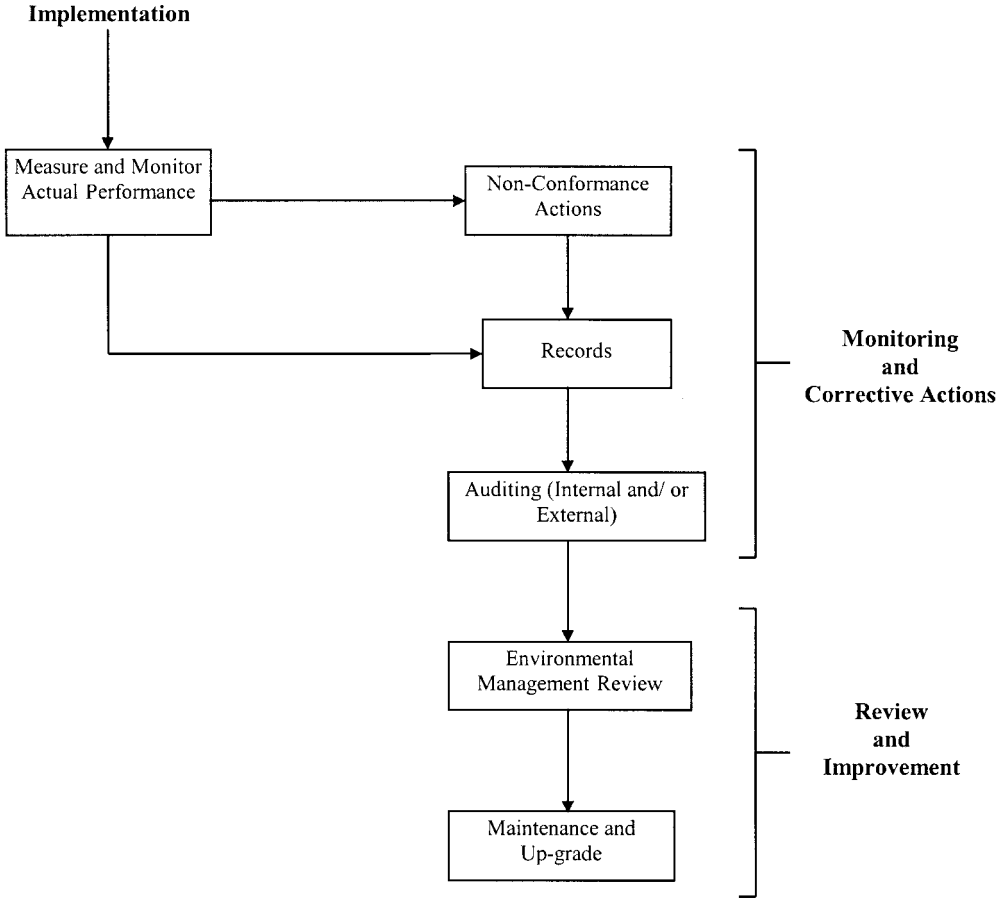

Figure 2 Systems diagram of ISO 14000 EMS process in monitoring and corrective actions, and review and improvement (compiled from ISO, 1996b)

Since the construction market is demand driven, the client must be the first to realize the viability of integrating environmental measures into a construction project. The Government, being the largest client of the construction industry in Singapore, should demonstrate how to incorporate an ISO 14000 EMS into construction projects.

The CIDB has a pivotal role in raising the industry's environmental awareness. It could give recognition to practitioners who attain exemplary environmental standards, and consider a joint CIDB-PSB ISO 14001 certification scheme. To aid firms' initiatives, the PSB could certify and label construction materials and products which conform to environmental standards. This would place the environmental discussion on a rational basis (Fiksel, 1996).

Conclusion

Unlike their counterparts in other sectors in Singapore, and construction firms in industrialized countries, Singapore contractors have not shown much interest in environmental management. Thus, action is required to address environmental issues in construction organizations and projects. The ISO 14000 EMS offers a means of achieving this. However, ISO 14000 is not a magic potion. It does not replace the environmental performance requirements in codes of practice, standards and regulations. Rather, it provides a system for tracking, managing and improving firms' performance with regard to those requirements.

Implementing an EMS offers many benefits to the construction organization. However, it is a difficult task. Yet, considering the success of ISO 9000 in Singapore and developments in other countries, ISO 14000 may become a mandatory requisite for construction companies in Singapore. When that day comes, companies which have initiated pilot studies on EMS or sought to understand the principles of ISO 14000 would have prepared themselves for it.

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