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Effective and economical development and implementation of environmental performance evaluation in small and medium size enterprises

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Effective and Economical Development and Implementation of Environmental Performance Evaluation in Small and Medium Size Enterprises

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ABSTRACT

Nowadays, diverse interested parties – non-governmental organizations (NGOs), regulators, investors, customers, and other stakeholders are demanding more meaningful information about organizations' environmental performances. Regardless of whether or not many companies have a certified Environmental Management System (EMS) in-place, they are becoming increasingly interested in Environmental Performance Evaluation (EPE) as an effective decision-making tool for managing the environmental aspects of their activities, products and services. While large companies have created diverse procedures, methods, and criteria depending on each organization's unique situation, Small and medium size Enterprises (SMEs) typically do not have enough resources to create and develop the evaluation procedures, criteria, and indicators by themselves. Accordingly, most SMEs around the world not only do not actively carry out environmental performance evaluations like large enterprises, but also do not establish environmental management systems.

This paper will help SMEs to identify and develop economical methodologies and systems for effectively evaluating environmental performance and to develop appropriate environmental performance indicators. In order to complete these objectives, several Environmental Performance Evaluation systems such as the Global Reporting Initiative (GRI) Sustainability Reporting Guidelines, the Environmental Self-Assessment Program of the Global Environmental Management Initiative (GEMI), the International Network for Environmental Management (INEM) Sustainability Reporting Guide, and ISO 14031, are compared and researched to identify and perform appropriate environmental performance evaluation and diverse environmental performance indicators which SMEs can implement.

Among 15 industry groups participated in this survey, the six industry groups, Utilities, Food Manufacturing, Beverage and Tobacco Product Manufacturing, Petroleum and Coal Products Manufacturing, Chemical Manufacturing, Computer and Electronic Product Manufacturing industries are actively assessing and reporting their environmental performance related to their activities, product, and service. Therefore, the SMEs in the six industries above and their subcontractors and contractors should seriously consider

establishing and implementing an EMS, like ISO 14001 and EPE, because it will assist them in gathering relevant information and assessing their respective performance.

Although an organization is a small or medium enterprise, it should not only consider following the trend of environmental management systems in use by many companies in around the world, but also try to promote sustainable development by evaluating their performance managing business aspects as well as environmental aspects. To fulfill effective and substantial performance evaluation in SMEs, they should have systematic and functional management elements in place such as organizational structures and assignment of responsibilities. The P-D-C-A cycle and EMS like ISO 14001 will help them to effectively evaluate their environmental performance.

Since SMEs may not have enough resources and capability to evaluate and analyze their performance, they should select and use comparative simple type of indicators such as Management Performance Indicators (MPIs) and Operational Performance Indicators (OPIs) according to ISO 14031 rather than economic and social performance indicators in terms of the GRI and INEM.

SMEs can receive several benefits if they use effective and substantial environmental performance; determine any necessary actions to accomplish its environmental performance indicator; identify significant environmental aspects; identify opportunities for better management of its environmental aspects; identify trends in its environmental performance; saving environmental costs through increasing the organization efficiency effectiveness;////In rapid competitive global markets, the values of companies' environmental activities have swiftly and widely been increasing as significant economical and social dimensions as well as environmental dimension. Accordingly, SMEs should response and follow the global trends and needs on environmentally friendly activities such as environmental management system and environmental performance evaluation so that they continuously develop and survive in swiftly powerfully competitive global markets.

Key Words: environmental performance; Environmental Management System (EMS); Environmental Performance Evaluation (EPE); decision-making; environmental aspects; Small and Medium size Enterprises (SMEs); criteria; indicators; economical methodologies; system; performance indicators; Global Reporting Initiative (GRI); sustainability; reporting; environmental self-assessment program; Global Environmental Management Initiative(GEMI); International Network for Environmental Management (INEM); ISO 14031; identify; develop; evaluate; industries; sustainable development; P-D-C-A cycle; Management Performance Indicators (MPIs) and Operational Performance Indicators (OPIs); economic and social performance indicators; significant; trends; saving environmental costs; efficiency; effectiveness; environmentally; friendly; activities; continuously; competitive; global markets.

1.0 Introduction

1.1 Objective of the Study

The objectives of this study are to:

- Identify and develop economical methodologies and systems for effectively evaluating environmental performance in small and medium size enterprises (SMEs) involved in various industrial categories including electronics manufacturing, telecommunications, oil and gas industry, and power generation;
- Develop appropriate environmental performance indicators for each category; and
- Demonstrate that environmental performance evaluation can be used to help SMEs move toward their environmental goals.

1.2 Significance of the Study

Recently, many forward-thinking firms and the public are paying more attention to the need to better manage environmental impacts, such as greenhouse gas emissions, bioaccumulation of toxic chemicals, ozone depletion. They also want to utilize and report the outcomes of managing such impacts. At the same time, diverse interested parties – non-governmental organizations (NGOs), regulators, investors, customers, and other stakeholders are demanding more meaningful information about organizations' environmental performances and trying to share a common interest in environmental performance in spite of the fact that no agreement has emerged on how to measure it and what kinds of criteria or standards are to be used. Environmental Management System, such as ISO 14001 and Eco-Management and Auditing Scheme (EMAS) have been implemented in many companies around the world since 1996 for ISO 14001. Regardless of whether or not they have a certified EMS in-place, many companies are becoming increasingly interested in EPE as an effective decision-making tool for managing the environmental aspects of their activities, products and services. However, existing EMS standards, like ISO 14001, do not completely explain performance evaluation procedures. So, some organizations, especially large companies, have created diverse procedures, methods, and criteria depending on there unique situations. Small and medium size enterprises typically do not have enough resources to create and develop the evaluation procedures, criteria, and indicators by themselves. Accordingly, most small and medium enterprises around the world not only do not actively carry out environmental performance evaluations like large enterprises, and also do not establish environmental management systems.

Today, after many large companies have implemented EMSs, most of them have tried to disclose their environmental performance reports annually in order to use the results of the environmental performance for business strategies. However, their performance reports may not be verified and comparable to those of other organizations because the tools they use may be very subjective and different. Therefore, setting standards or indicators to verify and compare environmental performance evaluations among companies may be needed. Such standards and indications can help the public to understand what the companies do, how much and what pollution they generate, and how much their environmental quality can improve.

Many companies have considered and included environmental elements and performance indicators as considerations for business decision making since they established their EMSs. Unfortunately, there is no generally accepted agreement on how to measure environmental performance. Given that good environmental performance is now high on the agenda of many firms, the lack of comparable and commonly accepted indicators is a major obstacle to continued progress.

1.3 Limitation of the Study

The scope of this study will be limited to:

- General procedures and methods identified in ISO 14031 Environmental Performance Evaluation Guidelines; and
- Various types of environmental performance indictors depending on characteristic of the organizations examined in this study.

It will not:

- Be limited to only organizations with established EMSs.
- Verify the data collected from organizations examined in this study.
- Identify the effects of an EPE report in public

1.4 Definitions of Small and Medium size Enterprises

There are different definitions of small and medium size enterprises (SMEs) varying according to objective and fields of study (see Appendix 1). The European Union (EU) defines SMEs based on the four criteria: number of employees, turnover, balance-sheet total and independence:

" SMEs are

- less than 250 employees and either
- an annual turnover not exceeding 40 million ECU or
- an annual balance sheet total not exceeding 27 million ECU, and
- independent enterprises, i.e. 25% or more of the capital or voting right cannot be owned by a larger enterprise " (Ruth Hillary, 1999)

There is inconsistency in the way SMEs are defined among the studies carried out in the EU even though the EU has such definitions of SMEs.

The European Commission DG XXIII and Organization for Economic Co-operation and Development's (OECD) Working Body for SMEs define SMEs as the following size –classes based on employee numbers

- micro-sized enterprise: 1 ~ 9
- small-sized enterprise: 10 ~ 99
- medium-sized enterprise: 100 ~ 499
- large-sized enterprise: > 500

SMEs are defined as enterprises with less than 500 employees in Case Studies in Environmental Management performed by The International Network for Environmental Management (INEM, http://www.inem.org), the world federation of non-profit environmental management associations and cleaner production centers. The other example of definition of SMEs is that SMEs are defined by the International Organization for Standardization (ISO) as companies with less than 500 employees.(Poul Buch Jensen, 1998, http://www.inem.org/htdocs/iso/jensen-sme.html)

The most common criterion used to define SMEs in most studies related to environmental case studies as well as business case studies is the number of employees because it is one of the most important and must be considered as inevitable in order to identify environmental aspects and impacts of a company.

For this research, I have defined SMEs as enterprises with less than 500 employees. I think the threshold of 500 employees is proper for wide application of EPE; comparison of performance among several enterprises; and being used as the definition of SMEs in diverse environmental case studies. It should be noted, however, that some companies on the high end of this scale may exhibit characteristics of larger companies.

1.5 Definitions of terms

Indicator: a basic and important part of the EPE process. This is a verbal description of some measurable environmental aspect or related factor to be assessed. Indicator is a general term that refers to all types of indicators in the management, operation, and state of the environmental systems. (ISO 14031, W.LEE KUHRE)

ISO 14001: Environmental Management Systems – Specification with guidance for use (ISO)

ISO 14031- Environmental Performance Evaluation: a guideline and not a requirement of certification. (ISO)

Eco-Management and Auditing Scheme (EMAS): A European community scheme allowing voluntary participation by companies performing industrial activities, established for the evaluation and improvement of the environmental performance of industrial activities and the provision of the relevant information to the public. (Source: Adapted from: European Commission. http://europa.eu.int/comm/environment/emas/emas_reg_en.htm)

Environment: surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation(ISO 14031)

Environmental Aspect: Element of an organization's activities, products or services that can interact with the environment (ISO 14031)

Environmental Performance Evaluation (EPE): Process to facilitate management decisions regarding an organization's environmental performance by selecting indicators, collecting and analyzing data, assessing information against environmental performance criteria, reporting and communicating, and periodically reviewing and improving this process. (ISO)

Environmental Management System (EMS): The part of the overall management system that include organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental (ISO 14001)

Environmental performance: results of an organization's management of its environmental aspects (ISO 14031)

Environmental Condition indicator (ECI): Specific expression that provides information about the local, regional, national or global condition of the environment (ISO 14031)

Environmental Impact: Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services (ISO 14001)

Environmental Performance Indicator (EPI): Specific expression that provides information about an organization's environmental performance (ISO 14031)

Environmental Indicators (EIs): the indicators for the state of the environmental

Operational performance indicator (OPI): Environmental performance indicator that provides information about the environmental performance of an organization's operations

Management performance indicator (MPI): Environmental performance indicator that provides information about the management efforts to influence an organization's environmental performance. (ISO 14031)

2.0 Background

2.1 The need for an Environmental Performance Evaluation (EPE)

EPE is a way to measure the outcomes of an organization's management of the environmental aspects of its activities, services, and products so that the organization can identify and accomplish its sustainable development and innovation goals. For an organization that wishes to have environmentally friendly activities, services on a continuous basis, and products, EPE of the most important and/or variable environmental factors may be the most cost-effective approach.

The characteristics of an environmental performance evaluation include the following:

- EPE can provide management methodologies or processes for encouraging an organization to measure and improve environmental performance on a continuous basis.
- The overall EPE process can supply an organization with a means to procure and assemble reliable and verifiable information that they can report to interested parties such as stakeholders, NGOs, government, customers, investigators, and internal customers.
- EPE process can give an organization an opportunity to improve its environmental aspects and impacts and to communicate environmental information.
- EPE can instigate the organization to identify opportunities for the prevention of pollution and help identify strategic business opportunities.
- EPE can provide substantial and efficient environmental indexes or indicators that can be integrated into performance evaluation of business strategic and company facilities.
- EPE can provide the principal elements to make regular environmental performance reports. If an organization wants to disclose environmental performance reports regularly, the organization should have explicit and objective indictors, which will appear in an EPE report and will be recognizable by interested parties.
- EPE can provide an organization with a performance evaluation system for its environmental activities, services, or products that can be assessed and integrated into business and economic values.
- EPE can encourage small and medium size enterprises to acknowledge the need to establish and implement an effective and proper Environmental Management System, to understand, fulfill, and accomplish economic and beneficial EPE in small and medium enterprises.

2.2 History of Environmental Performance Evaluation

Although a few components needed to carry out EPE have been implemented for ten or twenty years, the EPE term is relatively new. In 1969, the National Environmental Policy Act (NEPA) in

the U.S was improved to use the systematic environmental impact assessment processes, which have a lot of application to EPE. In 1970s, environmental indices were used to survey travel zones and air pollution modeling results (Horowitz, 1995). Even though this was not referred to as EPE, it embodied some of EPE concepts.

An environmental index system was created in the U.K. from 1980 to 1988. This system included objective environmental indicators and opinion poll results used to influence indicators into an aggregate index (Hope, 1922). This was one of the first reported attempts to gather environmental indicators.

By the end of the 1980s, risk assessments, such as health and ecological risk assessments, began to be popularly used. Ecological risk assessments are meaningful tools applicable to EPE.

Environmental impacts assessments relevant to EPE were proposed by many countries by the beginning of the 1990s. A study to appraise the financial resources associated with the conception of sustainable developments, which are related to EPE, was conducted by the World Bank. The study brought forth several cost-effective environmental impact assessment strategies which can supplement EPE (Querini, 1993).

In the early 1990s, the substantial development of environmental performance evaluation began with work done by TC 207. ISO 14031 was published as committee draft (CD) in1996, and a first edition of ISO 14031 was announced in 1999.

2.3 Environmental Performance Evaluation in various industrial fields

Environmental performance evaluation in diverse industrial fields can be different depending on their activities, services, or products. In other words because they have different environmental burdens based on different materials, processes, and products, they will collect, analyze, and interpret different indicators in accordance with their conditions and objectives. In this section, I will introduce an example of EPE within a few industries such as electronics manufacturing, telecommunications, oil and gas industry, and power generation.

Electronics Industry

First, the implementation of EPE for the electronic industry may be difficult because most electronic products consist of different sorts of parts and processes. The general EPE in this industry can include a wide range of environmental issues such as EPIs for:

- hazardous and solid waste storage,
- recyclable waste,

- chemical exposure,
- stack emission,
- resource use,
- waste water treatment,
- leak detection,
- above ground storage tank containment,
- process discharge, and
- groundwater monitoring well.

EPE indicators in electronic manufacturing should identify whether management has provided the resources, procedures, and systems needed to appropriately control environmental aspects and impacts of the organization. The especially important characteristic of this industry is the rapid changes of electronic products. This may make it difficult for electronic industries to establish and collect effective and meaningful indicators.

Telecommunications Industry

Second, the key point of EPE in the telecommunication industry is the hazardous waste created during operations and decommissioning of facilities. Most of the indicators in this industry may be related to hazardous wastes such as:

- mercury,
- radioactive tubes,
- PCBs,
- lead acid batteries, and
- lead sheath cable.

EPE for the telecommunication industry can cover:

- manhole water monitoring,
- storm water,
- hazardous and solid waste storage,
- chemical exposures,
- stack emissions from emergency generator, and

The most available source of EPE information in the telecommunication industry is probably related to solid and hazardous waste. Diverse indicators can be created in several processes, for example:

- construction of switching facilities,
- installation of pole and phone lines,
- providing the service, and
- decommissioning of the facilities.

Oil and Gas Industry

Third, the main activities in the oil and gas industry are exploration, drilling, initial processing of the product, transportation, and refining. According to these activities, the general EPE for this industry are:

- production wells;
- processor emissions;
- secondary containment and leak detection in storage tanks; and
- leak detection in pipelines.

Many environmental indicators for this area can be created corresponding to several processes such as:

- access road construction;
- well development and drilling;
- installation and operation of production equipment and pipe line, and
- product refining.

Power Generation Technologies

Last, most power generation technologies, such as coal, hydroelectric, fuel oil, natural gas, nuclear, solar and wind power, directly influence environmental impacts and have important effects on EPE indicators. The general elements for EPE in this area are:

- fugitive dust from ash pile;
- stack discharge;
- scrubber;
- chemical exposures;
- fugitive dust from fuel pile;
- air quality, cooling water discharge; and
- storm waster runoff.

Several environmental indicators for this area can be made corresponding to processes such as:

- construction of facility substations and lines,
- fuel unloading and storage,
- power generation, and
- decommissioning of the facilities.

3.0 Literature Review

3.1 Overview of Environmental Performance Evaluation (EPE)

Many organizations are trying to understand and assess the performance of diverse activities in order to improve the environmental impacts associated with them. After many organizations have established environmental management system like ISO 14001, they acknowledge the need for an environmental performance evaluation of diverse implementation of EMS, and want to report and understand how much and what to improve in their environmental impacts, how to avoid unnecessary environmental costs, and how to integrate EMS activities into business strategic like decision making elements. The ISO 14031-Environmental Management-Environmental Performance Evaluation Guidelines were published in 1993 in order to meet the related needs of many organizations.

Environmental Performance Evaluation (EPE) is a continuous process that provides the feedback necessary to effectively control an organization's activities, services, and products in order to improve its significant environmental aspects and reduce the impacts represented by them. If an organization implements an environmental management system, it will be able to use environmental policies, objectives, targets, and other activities to evaluate environmental performance. However, if an organization does not have an environmental management system, the EPE can still help the organization to do the following things (ISO 14031, 1999):

- identify its environmental aspects;
- determine which aspects it will treat as significant;
- set criteria for its environmental performance;
- assess its environmental performance against these criteria.

The EPE is a way to encourage an organization to measure and improve environmental performance based on continuous development.

The most important component of the EPE is the development and selection of meaningful and substantial indicators such as EPIs, MPIs, and ECIs. The results of EPE can be different depending on which indicators are used in diverse fields and how they are used.

3.2 The effects of Environmental Performance Evaluation.

If an organization appropriately performs an EPE, the organization can have the following benefits (ISO 14031 Environmental Performance Evaluation, W.Lee Kuhre, 1997):

- Determining whether goals, objectives, targets, and other programs are satisfied

- Tracking the link between environmental performance and management effort, financial investment;
- Establishing benchmarks for environmental performance in business strategic planning and marketing;
- Providing external and internal environmental reporting and communication with interested parties such as government, NGOs, customers, investors, and other stakeholders;
- Identifying opportunities for the prevention of pollution through identifying basic problem or root causes;
- Helping with eco-efficient management
- Encouraging an organization to establish EMS, and moving an existing EMS toward continual improvement.
- Supporting environmentally friendly activities, service, and products

3.3 The Relationship between EPE and Environmental Management System

The original design of the EPE was to support and to be a part of the larger EMS (CEEM, July 1996). If an organization has environmental policies, objectives, targets, and other programs needed to carry out an environmental management system, the organization would be able to conduct efficient and beneficial EPE through measuring and managing them.

Although there is controversy regarding whether an EMS should be in place before the EPE, an EPE can be implemented with a limited range when no EMS exists. It thus may not be necessary to establish an EMS for an EPE. In fact, an effective EPE can help an organization to establish and implement an EMS. "Others said that EPE cannot stand alone or be there before the EMS is set up. No matter which is first or even if they develop in parallel, the EPE can be used to help identifying aspects and to come up with the objectives, targets, criteria, and environmental performance baselines" (ISO 14031 Environmental Performance Evaluation, W.Lee Kuhre, 1997). The ISO has said that the EPE should be based on as many of the aspects of the organization as are known at the time (ISO/TC 207/SC4, 1996)

The best approach, however, is for both EPE and EMS to be implemented together and at the same time instead of being done independently and/or sequentially. I would like to say the relationship of both is collaborative not independent. If an organization establishes only one of the two, it may lose benefits and waste resources.

3.4 ISO 14031, Environmental Performance Evaluation Guidelines

ISO 14031 is one of the ISO 14000 series of guidance documents; it supports the other system elements and is not a requirement of certification. It supports ISO 14001, Environmental Management Systems specification, and ISO 14004, Environmental Management System –General guidelines on principle, system and supporting techniques.

The main goal of ISO 14031 is to encourage the use of EPE and to improve environmental performance by supplying information about the results of environmental policies, objectives, and targets. EPE catalyzes continual improvement of environmental performance, encourages minimization of environmental aspects and impacts, and helps to increase business-related benefits.

The scope of ISO 14031 includes organizations of all, sizes, types, locations, and complexities.

The ISO EPE Subcommittee (SC), which is subcommittee of Technical Committee 207 (the ISO committee responsible for developing the ISO 14000 series of standards), recommends that EPE should progress through seven major steps:

1 planning activities,
2 collection of data,
3 analysis,
4 conversion into indicators,
5 evaluation of information,
6 comparison against criteria and
7 reporting.

The main activities for planning EPE should emphasize the selection of indicators. Significant environmental aspects and impacts, environmental performance criteria, environmental information including several regulations, demands and concerns of internal and external stakeholders will be used to set the indicators.

The general procedures of implementation of EPE in accordance with ISO 14031:1999 are the following:

- Plan: (Step 1) planning EPE, selecting indicators for EPE
- Do: using data information which includes
  - (Step 2) collecting data relevant to the selected indicators.
  - (Step 3) analyzing and (Step 4) converting data into information describing the organization's environmental performance.
  - (Step 5) assessing information describing the organization's environmental performance in comparison with the organization's environmental performance criteria (Step 6).

- (Step 7) reporting and communicating information describing the organization's environmental performance.

- Check and Act: reviewing and improving EPE.

Indicators for EPE in ISO 14031 are environmental performance indicators (EPIs), and environmental condition indicators (ECIs). EPI is further divided into management performance indicators (MPIs) and operational performance indicators (OPIs).

3.5 Methodology, Procedures, and Technology to Implement EPE

There is no one way or universal method for doing EPE that will work for all types and sizes of industry in all parts of the world (CEEM, July 1995). Evaluation methodologies are different depending on an organizations unique environmental activities, services, and products. However, the most important and common steps are to develop, set up, collect, and interpret meaningful data. In general, Figure 1 represents environmental performance evaluation procedures. Figure and theories used in this step were cited from ISO 14031 Environmental Performance Evaluation, W.Lee Kuhre, 1997.

3.5.1 Preliminary Activities and Planning

- Identifying critical resources, e.g., staff, money and budget, computer, files, etc.
- Getting commitment of top management: To successfully and effectively implement an EPE, the commitment of top management is absolutely necessary.
- Obtaining necessary resources: The necessary resources must be identified and supplied.
- Forming an EPE team: Team members should include environmental, production, legal, HR, and risk departments.
- Preparing an EPE Scope, goals, and objectives: the scope, goals and objectives as a basic boundary of the EPE are set up in the early stage of the EPE procedures.
- Determining Major EPE organization or subdivision: The team should decide on how they will subdivide the task.
- Preparing the overall EPE plans: The team should determine what they will do each step of the process.
- Preparing working documents, procedures, and tools: The team should set up various

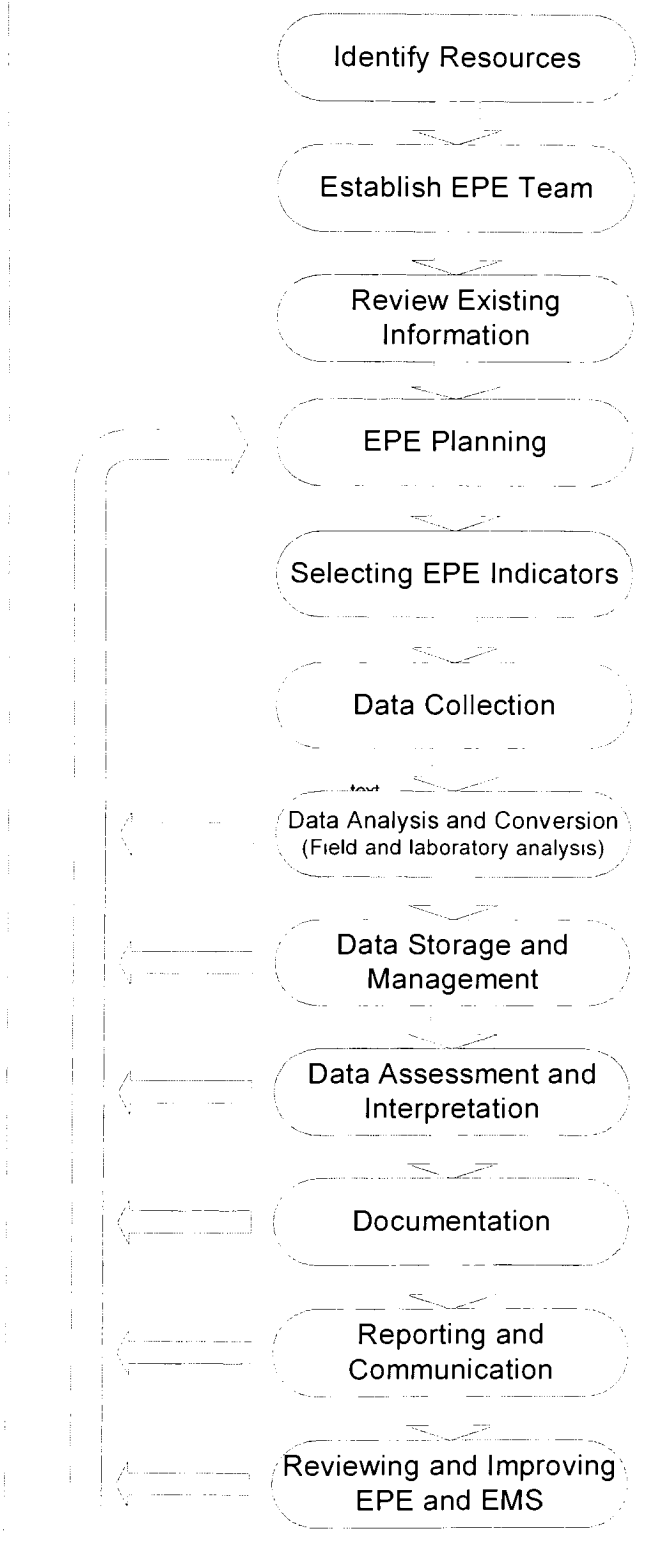

Fig. 1. EPE Procedures

working documents, procedures, and tools needed to effectively do their job during implementing the EPE.

3.5.2 Review and Use of Existing Information.

If an organization ignores and does not review existing information related to an EPE, the organization must spend a lot of money and time to get the information by other means. Organizations must avoid such wasteful activities. They should do the following to get the most benefit:

- Review and use policies, goals, objectives, targets, and environmental criteria: If an organization has already established environmental policy, goals, objectives, targets, and various other environmental criteria, the organization should collect, review, and incorporate them into the EPE process.
- Review the use of environmental aspects and impacts information: an analysis of aspects will make the EPE more valuable and useful for management. This step promotes the development of useful measurement data and the setting of relevant worth.
- Review and use other background materials: to effectively and broadly carry out the EPE, the organization should review general documentation, existing environmental performance data, environmental documentation, and operational system documents.

3.5.3 Selection of Indicators and Metrics

The principal roles of Environmental Management Indicators (EMIs), Environmental Performance Indicators (EPIs), and Environmental Indicators (EIs) are as quantitative or qualitative descriptors to express environmental performance. Thus they are very important indicators for EPE. Indicators may be in different types of formats, such as:

- an absolute indicator, which is usually a fixed measurement scale type of metric,

- a relative indicator, which is expressed in relationship to another measure,
- a qualitative indicator, which utilizes a value scale, and
- a quantitative indicator, which is a simple numerical metric.

3.5.3.1 Characteristic of Indicators

To accomplish successful and explicit results of an EPE, an organization should define and acknowledge the desirable characteristics of indicators in order to distribute indicators into appropriate areas and fields. If the organization chooses and utilizes meaningful and balanced indicators in accordance with its characteristics, the results of its EPE will be of much greater value. Accordingly, the organization should consider the following guidelines. Indicators should:

- be representative of the true organization;
- point to root cause of the impact;
- helps prevent problem;
- be understandable;
- focus on significant environmental aspects;
- promote benchmarking;
- be consistent with environmental policy and objectives;
- be controllable and verifiable; and
- provide for cross-functional comparisons and linkages.

The indicators and metrics should meet business goals and strategies. Improvement should also provide a competitive advantage together with improved profitability.

3.5.3.2 Selecting Indicators

An organization should consider and decide on methods to select a few indicators because they are used both inside and outside of organizations to track performance. The fact is that there are

several types of methods for selecting indicators that can be used effectively in diverse industries. EPIs should be able to:

- track progress toward the organization's goals;
- be comparable with other organizations; past environmental impacts, and other performances over time;
- be used to decide on business decisions or be used to integrate environment into business language;
- have confidential business information and reliability;
- be used for benchmarks in long term business strategy;
- confirm whether the organization complies with regulations and laws;
- be used for an internal incentive standard.

The main approaches for selecting indicators for EPE are:

- Cause and effect approach: an organization can develop indicators that may be the fundamental or basic cause of its significant environmental aspects and impacts.
- Risk-based approach: an organization can determine and develop indicators that may be based on considerations of the risks which the organization's management determines is related to special activities, products, or services.
- Life cycle approach: an organization can develop indicators related to inputs and outputs materials of product and significant environmental aspects and impacts for the entire life of a product.
- Regulatory or voluntary initiative approach: an organization can identify indicators related to regulations and voluntary performance requirements.

Methods for selecting indicators can also include: Plan-do-check-Correct, cause-effect, tracing an indicator through management system (MS), Operational System (OS), and Sate of the Environment (SOE), input-output, and functional aspect analysis.

- Plan-do-check-correct: Plan- the number of training programs identified, DO-the number of training programs implemented, Check- the average test score, Correct-updates to the training module. (ISO/TC207/SC4/JEG, 1996)
- Cause-effect: identify (a) cause(s) and effect or impact to occur. This can help the EPE team to consider significant or obvious issues.
- Tracing an indicator through management system (MS), Operational System (OS), and Sate of the Environment (SOE): Indicators selected should show the tracing the events through MS, OS, and SOE.
- Input-Output: This method includes measuring a factor of input (an aspect) and measuring the results of output (the action taken).
- Functional Aspect Analysis: the functional analysis could include an assessment of issues such as flexibility, ability to accomplish objectives, coordination, and ability to solve problems (ISO/TC/207/SC4/JWG, 1986)

3.5.3.3 Categories of Indicators

It may be necessary to categorize indicators in order to reduce the many measurements and related issues. This category must be flexible without fixing. For example, groups of indicators are:

- conformity,
- system and implementation,
- integration of issues,
- economic leadership, and
- management (ISO/TC/SC4/JWG, 1996).

Indicators can be divided into three main types as specified by SC4, management system, operational system, and state of the environment. Management system EMI can encourage an

organization to assess the designs, plans, and action taken by management. The operating system starts its role after implementing management activities.

The output derived by the indicator system can be used to establish new environmental policy, environmental objectives and targets, and improved operation system for the sustainable development. Indicators will be implemented through all system areas. Table 1, Table 2, and Table 3 are examples of indicators in ISO14031: 1999(E), Annex A.

Examples	Indicators
Implementation of policies and programmes	➢ Number of achieved objectives and targets. ➢ Number of organizational units achieving environmental objectives and targets. ➢ Degree of implementation of specified codes of management or operating practice ➢ Number of prevention of pollution initiatives implemented
Conformance	➢ Degree of compliance with regulations ➢ Degree of conformance of service providers with requirements and expectations specified by the organization in contracts ➢ Number of or costs attributable to fines and penalties ➢ Number of audits completed versus planned
Financial performance	➢ Costs (operational and capital) that are associated with a product's or process' environmental aspects ➢ Return on investment for environmental improvement projects ➢ Saving achieved through reductions in resource usage, prevention of pollution or waste recycling ➢ Sales revenue attributable to a new product or a by-product designed to meet environmental performance or design objectives
Community relations	➢ Number of inquiries or comments about environmentally related matters ➢ Number of press reports on the organization's environmental performance ➢ Number of environmental educational programmes or materials provided for the community ➢ Number of sites with environmental reports

Table 1 – Management Performance Indicators (MPIs) - ISO 14031: 1999(E), Annex A

Examples	Indicators
Materials	➢ Quantity of materials used unit of product ➢ Quantity of processed, recycled or reused materials used ➢ Quantity packing materials discarded or reused per unit of product ➢ Quantity of raw materials reused in the production process
Energy	➢ Quantity of energy used per year or per unit product ➢ Quantity of energy used per service or customer ➢ Quantity each type of energy used ➢ Quantity of energy generated with by-product or process stream
Service supporting the organization's operations	➢ Amount of hazardous material used by contracted service providers ➢ Amount of cleaning agents used by contracted service providers ➢ Amount of recyclable and reusable materials used by contacted service providers ➢ Amount or type of wastes generated by contracted service providers
Physical facilities and equipment	➢ Number of pieces of equipment with parts designed for easy disassembly, recycling and reuse ➢ Number of hours per year a specific piece of equipment is in operation ➢ Number of emergency events or non-routine operations per year ➢ Number of hours of preventive maintenance to a equipment per year

Table 2 – Operational Performance Indicators (OPIs) - ISO 14031: 1999(E), Annex A

Examples	Indicators
Supply and delivery	➢ Average fuel consumption of vehicle fleet ➢ Number of freight deliveries by mode of transportation per day ➢ Number of vehicles in fleet with pollution-abatement technology ➢ Number of business trips by mode of transportation
Products	➢ Number of products introduced in the market with reduced hazardous properties ➢ Percentage of a product's content that can be reused or recycled ➢ Duration of product use ➢ Number of units of energy consumed during use of product
Service provided by the organization	➢ Amount of cleaning agent used per square meter ➢ Amount of fuel consumption ➢ Quantity of licenses sold for improved processes ➢ Number of environmentally-related credit risk incidents or insolvencies
Wastes	➢ Quantity of waste per year or per unit of product ➢ Total waste for disposal ➢ Quantity of waste converted to reusable material per year ➢ Quantity of hazardous waste eliminated due to material substitution
Emissions	➢ Quantity of specific emission per year ➢ Quantity of specific emission per unit of product ➢ Quantity of waste energy released to air ➢ Quantity of emissions having ozone depletion potential

Table 2 – Operational Performance Indicators (OPIs) - ISO 14031: 1999(E), Annex A

Regional, national, or global	Indicators
Air	➢ Concentration of a specific contaminant in ambient air at selected monitoring location ➢ Ambient temperature at locations within a specific distance of the organization's facility ➢ Opacity levels upwind and downwind of the organization's facility
Water	➢ Concentration of a specific contaminant in groundwater surface water ➢ dissolved oxygen in receiving water ➢ change in groundwater level
Land	➢ Concentration of a specific contaminant in surface soils at selected locations in the area surrounding the organization's facility ➢ Area rehabilitated in a defined local area ➢ Paved and non-fertile area in a defined local area
Flora	➢ Concentration of a specific contaminant in tissue of a specific plant species found in the local or regional area ➢ Crop yield over time from fields in the surrounding
Fauna	➢ Concentration of a specific contaminant in tissue of a specific animal species found in the local or regional area ➢ Population of particular animal species within a defined distance of the organization's facility
Humans	➢ Longevity data for specific populations ➢ Rate of population growth in the local or regional
Aesthetic, heritage and culture	➢ Measure of the condition of sensitive structure ➢ Measure of the condition of places considered sacred in the vicinity of the organization's facility

Table 3 – Environmental Condition Indicators (ECIs) - ISO 14031: 1999(E), Annex A

3.5.4 Quality tools for development indicators and for interpretation

The quality toolboxes for collecting, interpreting, and selecting environmental performance indictors and data help the EPE team to effectively do their job; to identify and quantify environmental problems; to improve the serious problem-solving skills of all employees in the organization; to evaluate, control, and improve key processes. The Plan-Do-Check-Act cycle (PDCA) for environmental performance evaluations and indicators will be used to:

- Plan what kinds of data you would like to complete during a given time and what you need to do to get in your organization.
- Plan what kinds of data you would like to complete during a given time and what you need to do to get in your organization.
- Do what you plan on doing. You should begin a small size with a pilot program.
- Check the results of what you did to see if you accomplished your objective.
- Act on the information. If you accomplish this completely, you should standardize the plan. If not, last with the cycle to improve. (Pascal Dennis, "Quality, Safety, and Environment Synergy in the 21st Century", 1997)

The quality toolboxes for collecting, interpreting, selecting environmental performance indictors and data help the EPE team to effectively and statistically fulfill their job. The original seven quality tools are used to apply to determine environmental performance indicators

- Flowchart:
  - ✓ To identify kinds of measurements related to critical environmental impacts.
  - ✓ To identify the potential problems and contingency indicators needed to be monitor within a process or flow.
- Check sheet:
  - ✓ To monitor and record measurement and performances regularly.
  - ✓ To identify a list of outcomes of performances.

- Iishikawa diagram:
  - ✓ To analyze indicators to identify not only contributing performance factors, but also unfriendly environmental aspects and impacts.
  - ✓ To determine apparent and root causes of events.
- Pareto diagram:
  - ✓ To identify the priority issues that should be affected significant environmental impacts.
  - ✓ To determine what a company measures, for example, pollution concentration, total amount of waste a year.
- Histogram:
  - ✓ To identify and rank the issues, aspects, and causes of problems using statistical processes.
  - ✓ To show distribution of causes and results of outcomes of performance through median and average or mean.
- Run charts:
  - ✓ To track performance over time.
  - ✓ To attempt to anticipate causes of performances through trends.
- Control chart:
  - ✓ To illustrate the trends and define an upper control limit and a lower control limit that is statistically computed based on the actual or sample population.
  - ✓ To provide the case in order to improve performance. (Pascal Dennis, "Quality, Safety, and Environment Synergy in the 21st Century", 1997)

3.5.5 Collection of Environmental Performance Data

The process for collecting EPE data should be appropriate, systematic, and scientific because

these data must be verifiable, reliable, and accurate. If the quality of the data collected is low level, it may be difficult for the team to interpret and understand them, and the results of the EPE are lost reliability. Accordingly, collecting environmental performance data must be considered significantly.

3.5.5.1 Available Sources of Data.

All of the following are possible sources of data (ISO/TC207/SC4/JWG, 1996): emission monitoring data, discharge monitoring data, EMS procedures, legal requirements, output from management systems, reporting data, production data, inventory data, financial data, environmental impact statements, agency documents, inventory records, regulatory reports, and raining records.

The data derived from these sources should be of good quality in order to achieve proper and efficient use of environmental indicators. Because data quality, validity, accuracy, and reliability are important, data used to interpret EPE should go through a quality review including such elements as time of collected date, limitation of data, verifiability, and data completeness.

Data can be collected by measurements, observations, interviews, and review of files. Observation may be a meaningful source of information for the EPE process. Interviews with employees can help to learn of spills, poor disposal practices, lack of cooperation with recycling, improper maintenance of emission equipment, and diverse important information. Files for review should cover manifests, hazardous material business plans, permit applications, permits, emission reports, weight receipts, and other materials. The collected data will be kept in several types such as paper files, microfiches, and computer disc storage. These data must be protected by fire, theft, error, or other unexpected events.

3.5.6 Interpretation and Evaluation of Data

One step in interpreting and evaluating data is to determine the value of the data. Some

organizations use a software program to conduct statistical analysis of data so as to explicitly and objectively evaluate and interpret environmental performance and data. Mean, average, range, standard deviation, and other statistics will support the EPE team in reaching interpretations and conclusions about the data and the organization's environmental performance. In general, the procedures of interpretation and evaluation of data are three steps: initial evaluation of data, mathematical and statistical evaluation, and reaching interpretation and evaluation. Theories used in this step were quoted from ISO 14031 Environmental Performance Evaluation, W.Lee Kuhre, 1997.

3.5.6.1 Initial Evaluation of Data

- Conversion of unit: converting the units reported to be consistent might be the first step in order to make sense of the data. This conversion will help provide an accurate and consistent interpretation of the data.
- Comparison to regulatory standards: If the data indicates that regulatory standards are being met, there is a good chance that the organization is meeting its performance goals. On the other hand, if the data indicates that regulatory standards are being slightly exceeded, it may not imply the organization's bad environmental performance because the regulatory standards are set up to conservative and protective levels.

3.5.6.2 Mathematical and Statistical Evaluation

Another important part of the EPE is mathematical and statistical calculations because these calculations help determine the validity of the results. Average, means, and ranges are a form of preliminary data handling. Statistical approach is a good method to get new insight from raw data. Coefficient of correlation and standard deviation are used more than other statistical calculations. Three general categories of statistical analysis, points of central tendency, dispersion or deviation, and correlation are also used in mathematical and statistical evaluation for the EPE.

- Points of central tendency: the common points of central tendency are median, mode, and mean. In the EPE the median number of samples taken is an example of use of this statistic. The mean is the point at which the whole weight of values or scores is in balance and means the center of all the measurements being discussed.
- Dispersion or deviation: the figure of data curve, the range of data, the amount of skew, the average deviation, standard deviation, and variance are used to define dispersion or deviation of data.
- Correlation: this will help to see the interrelationship between different types of data. Correlation will allow the EPE team to understand the intensity and magnitude of the data relationship.

3.5.6.3 Reaching Interpretation and Evaluation

Cumulative effects analysis (CEA), such as network analysis, ecological modeling, expert opinion, spatial analysis, and multi-criteria evaluation can be used to reach interpretation from data. Most approaches to CEA involve setting goals, establishing spatial and temporal boundaries, determining the environmental baseline, defining impact factors, identifying threshold's impact analysis, and integration of monitoring data (Clark, 1994).

Interaction matrices, networks and checklists are used to help interpretations. The interaction matrices can show the activities as rows and the environmental factors as columns or vice versa. Networks can identify interrelationships between actions or causes and corresponding impacts. The checklist shows a simple listing of environmental impacts, factors, actions, and a complicated degree of the factors and the use of scaling of the impacts (Canter, 1992).

3.5.7 Report, Record, Documentation, and Communication of the Results of the EPE

After the data has been interpreted, an organization may prepare an EPE report, and

communicate it to external or internal interested parties. When an organization reports and communicates the results of the EPE, the organization should provide a brief and explicit executive summary for those who do not have enough time to read it. Theories described in this step were cited form ISO 14031 Environmental Performance Evaluation, W.Lee Kuhre, 1997.

3.5.7.1 General Characteristics

The format requirements for the EPE report are not fixed and a key element of them is to include an executive summary at the early of the EPE report. The executive summary must explain the key observations, conclusions, and recommendations, and can cover the in management area, operational area, state of the environment, and product and process type.

Confidentiality of certain EPE information must be kept because the EPE report may contain trade secret information or that which would give a competitor an unfair advantage.

Since a lot of EPE results are based on observations and subjective interpretation of the EPE team, it is important that reports and evaluations are systematically carried out so that they are traceable,. The report should be traceable in terms of the amount of time spent, experience of the individual involved, and other information related to the plan, procedure, and report. The EPE report should include backup documentation concerning significant impacts, problems, or nonconformities. The EPE report should quickly, clearly, and simply present only facts without the EPE team's opinions and judgments. Wordy or complex statements in the EPE report should not be included. Uncertainty should be disclosed in the EPE report in order that the audience can know that the process cannot be totally accurate and that conditions may be different from day to day. To present an accurate and useful EPE report, the EPE team should keep the data confidential until making the EPE report. The EPE report should get feedback from readers and such feedback should help the organization to improve their environmental performance.

3.5.7.2 Content

Diverse audiences want to know various types of information because unique fields of interest, time, and acknowledgement of the EPE are different depending on people. Table 4 is general EPE content for different audiences. The EPE reports should contain the following information from the review of numerous documents that relate to the environment; manifest, hazardous material management plans, chemical inventories, monitoring results, environmental impacts reports, policy statements, training records, and standard operation procedures.

Contents	Management	Relevant Depts.	All employees	Applicable agencies	public
Introduction	X	X	X	X	X
Site and product information		X			
Assessor Team information		X		X	
Objective, scope, and criteria		X			
Process used		X			
Findings and raw data		X			
Interpretations, discussion, and conclusion		X		X	
Recommended Improvements	X	X			
Summary	X	X	X	X	X
Reference		X			

Table 4 EPE Content for Different Audiences

3. 6 Environmental performance in Small and Medium size Enterprises (SMEs)

The importance of environmental impact of small and medium size enterprises has increased because many interested parties such as large companies, several stakeholders, and government

have forced and stimulated SMEs to improve and address environmental issues related to environmental activities, products or services. Examples of these efforts include creation of environmental policy and objectives, environmental management system, ISO 14001 certification, environmental performance evaluation. SMEs should consider what interested parties, including internal customers, want with respect to environmental actions so that they can build and maintain lasting beneficial and worth while relationships with their customers. However, only a very few small companies have taken advantage of sound relationship between good environmental management practice and good business practice because of the following causes:

- a lack of funds, human resources, technology;
- the need for environmental management and performance evaluation, and data relevant to environmental performance and action;
- negative bias, which a small or medium- sized enterprises may not have significant environmental impacts;
- a belief that current methods are the most efficient; and
- a fear of any changes.

SMEs may have to overcome these causes to survive in the competitive global market. If they embrace several key elements of assistance such as motivation, support, and effective solution to these causes, they may easily establish and maintain appropriate environmental management system and performance evaluations.

The main motivations for SMEs are:

- reduction of costs
- compliance with environmental regulations
- improvement of the company image in the global market

Activities to support them are:

- access to information related to environment management system and performance

- practice transfer and supporting grants
- workgroups

Solutions may include:

- checklist and best practice reviews
- audits and training
- implementation of ISO 14001, health and safety, total quality management, and integrated management system.

The EPA's Performance Track Program, which is designed to acknowledge and stimulate environmental performers – those who perform beyond compliance with regulations and laws, encourages small, medium, and large facilities to implement and maintain environmental performance evaluation system. EPA encourages them to participate, not only in EPA's sustainable industries program, Design for the Environment, and voluntary partnership program, but also in this Nation Environmental Performance Track Program.

The main eligibility criteria for small and medium companies are:

- Environmental Management system EPA suggests that small companies should implement this national Environmental Performance Track Program within an EMS. To support small facilities' implementation of an EMS, EPA will make guideline documents and assistance materials available
- Continuous Improvement – EPA requires that small companies implement the documented and improved activities related to at least one environmental aspect in several categories
- Community Outreach and Reporting – There is no standard set of outreach action beyond the Annual Performance Report, which is distributed and reported in accordance with size, scale of operations and setting of a small company. A small company should be able to make documentation relevant to designation of contact point with company management

and procedures to respond to questions or interesting of interested parties such as neighbors and local government.

- Sustained Compliance – EPA requires small companies to maintain several records relevant to compliance at the same level as other companies' participating in the Performance Track program.
- Annual Performance Reporting to EPA – EPA is trying to support specialized assistance in this area

3.7 Regulation and Laws related to the EPE

Although the EPE does not consider regulatory performance for compliance with regulations or laws, the EPE should deal with standards or criteria of regulations identified, fines, and permits. Environmental regulations are different depending on the local, state, regional, national, and others. EPA may focus more on hazardous waste regulation than on other environmental regulations may be focused in the view of the EPE because hazardous waste has caused huge environmental damage over the number of years. The Toxic Substance Control Act (TSCA), the Hazardous Material Transportation Act (HMTA), the Superfund Amendment and reauthorization Act (SARA Title), the Occupational Safety and Health Act (OSHA), the Resource Conservation and Recovery Act (RCRA) are related to hazardous material regulation in the U.S. The results of activities covered by these regulations can provide useful data for the EPE. The Clean Water Act, Oil Pollution Act, the Safe Drinking Water Act, Clean Air Act, Emergency Planning and Community Right-to-Know Actor, the National Environmental Policy Act (NEFA), Pollution Prevention Act, Endangered Species Act in the U.S may also require data collection. (W.Lee Kuhre, ISO 14031 Environmental Performance Evaluation, 1997)

3.8 Literature Review Conclusion

Many progressive organizations acknowledge the need to better manage the environmental impacts of their activities, services, and products. Interested parties Non-Governmental Organizations (NGOs), regulators, investors, customers, and other stakeholders are also demanding more meaningful information on the organizations' environmental performance. Environmental Performance Indicators (EPIs) can supply the information needs of the business manager, as well as other outside organizations.

Such demands of various interested parties for information about environmental performances are continuously increasing and some of these parties share common interests in environmental performance even though they recognize that the ways to measure and evaluate environmental performance have not been agreed upon.

Many organizations are trying to know and assess the performance of diverse activities implemented to improve their organization. Especially, after many organizations have implemented an environmental management system like ISO 14001, they acknowledge the need for environmental performance evaluation of their EMS in order to determine improvement regarding their environmental impacts and economic benefits. They also need to understand how best to integrate EMS activities into business strategies and decision making. The ISO published international standard related to environmental performance, ISO 14031-Environmental Management-Environmental performance evaluation-Guidelines in 1993 in order to help organizations meet their EPE needs.

The EPE is a continuous process to evaluate the environmental performance of an organization. The EPE can help an organization effectively control its activities, services, and products to improve their significant environmental aspects and impacts represented by them.

The most important component of the EPE is the development and selection of meaningful and substantial indicators such as EPIs, MPIs, and ECIs. The results of the EPE can be different

depending on which indicators and how are used in diverse fields.

After the data has been interpreted, an organization shall make the information about the EPE report, available to external or internal interested parties. When an organization reports and communicates the results of EPE, the organization should consider and make a brief and explicit executive summary for those who do not have enough time to read the whole report.

4.0 METHODOLOGY

4.1 Description of Methodology and Schedule

The goals of this thesis are to determine effective and economical methodologies or systems for environmental performance evaluation for SMEs to develop useful environmental performance indicators (EPIs), and to demonstrate how the results of EPE and EPIs can be utilized for establishing an organization's strategies, and environmentally friendly process and product design. To meet these goals I have selected 52 large companies in order to identify prevalent environmental performance indicators and existing distribution of environmental performance reporting in diverse industries around the world.

Research and running into unexpected trial and errors I figured out different methods to research this thesis.

Different methods and thoughts were suggested through research and case studies. The method proposed was to research existing management, product, and quality evaluation, such as an accounting assessment and the Malcolm Badridge National Quality Award, and to study methods to apply as environmental performance indicators through statistical process control (SPC). However, these methodologies are no longer necessary. The reasons for not using these methods were:

- Limitation of data collection needed to research these methodologies;
- Difficulty of selecting appropriate existing management systems to compare and apply to environmental performance evaluation;
- Worthlessness of comparing performance evaluation guidelines using other areas. This study for SMEs would rather compare and research existing environmental performance evaluation guidelines published in environmental aspects than do performance evaluation guidelines using other aspects; and
- Complicated concepts to SMEs

Instead, I have reviewed existing environmental performance evaluation programs such as the Global Reporting Initiatives (GRI) Sustainability Reporting Guidelines, the Environmental Self-Assessment Program published by the Global Environmental Management Initiative (GEMI), and the International Network for Environmental Management (INEM). This is because many global companies around the world are using these programs to evaluate and report their environmental performance as well as their economic and social performance. Many interested parties, such as stakeholders and investors, also are very interested in indicators of such programs such as

economic, environmental, and social performance indicators. In addition, such indicators may help SMEs to use significant indicators as benchmarking for sustainable development.

I have reviewed the relationships between an environmental management system and an environmental performance evaluation in order to identify an appropriate management system for implementing effective environmental performance evaluation in SMEs. I developed an approach to disclose and improve upon an annual environmental performance report.

The period to accomplish this thesis covered about six months. Two months were spent collecting data and cases, and a month for selecting indicators. The remaining activities such as the substantial reviews, interpretation, and proposal of new theory were performed during 3.5 months. A month was devoted to reviewing efficiency and effectiveness of environmental performance evaluation in entire systems.

4.2 Procedures

To accomplish my goals, I performed the following steps:

- Selected 52 companies to identify the need for and effects of EPE through identifying successful case studies of EPE use in large companies;
- Used the North American Industry Classification System (NAICS) to classify types of industries because NAICS is used throughout the world;
- Identified several environmental performance indicators commonly used and distribution of industries disclosing and evaluating environmental performance through sample companies' Internet home pages;
- Reviewed existing environmental performance evaluation systems or guidelines using them in sample companies in order to identify the trends of indicators and systems to implement performance evaluation for SMEs; and
- Reviewed and determined an appropriate implementation system and indicators for SMEs to implement eco-efficiency.

4.3 Data collection

4.3.1 Case Studies

To review and survey successful case studies of EPE, 52 companies were selected. 40 companies among them were members of the Global Environmental Management Initiative and the rest of them were companies using the GRI guidelines. These case studies and several environmental

performance evaluation guidelines were collected through professional papers, publications, and Internet web sites. In particular, 52 companies' environmental performance reports disclosed on their Internet home page were surveyed and used to review environmental indicators. I surveyed the relationship or comparable qualities between an environmental management system and a performance evaluation system so that I could provide an effective environmental management and performance system for small and medium sized enterprises.

4.3.2 Data Collection

Before collecting data, I defined categories for data in order to reduce meaningless data and issues and to efficiently interpret the results of the data. After that, various indicators as a questionnaire were created according to several categories such as MPIs, OPIs, and ECIs. The results of each performance indicator were collected and interpreted in sample companies in order to identify effective and integrated indicators. I collected these data through the Internet and published reports from government, private companies, and industry representatives. 24 MPIs, 15 OPIs, and 5 ECIs were created to survey this paper. Operational Performance Indicators were collected and divided into two types of indicators, quantitative and qualitative, in order to review types of indicators used in large companies.

I tried to find which indicators were required in accordance with specific countries and industries. It was not to compare indicators in terms of countries because of the following; most sample companies were global companies around the world; they evaluated and reported global and common indicators with normalized values; they used representative indicators in global branch companies. Indicators related to industries were different according to their characteristics such as products and activities.

4.3.3 Various Management Performance Evaluation Standards.

To identify an efficient environmental performance evaluation system for SMEs, I surveyed voluntary standards and guidelines relevant to performance evaluation, such as Global Reporting Initiative (GRI), Global Environmental Management Initiative (GEMI), International Network Environmental Management (INEM), World Business Council for Sustainable Development (WBCSD), and International Organization for Standardization (ISO). These standards and guidelines included management procedures, categories, criteria, and rewards.

I compared requirements and indicators described in these guidelines with the result that indicators were used in this survey in order to review suitable management performance evaluation methods to implement and apply appropriate environmental performance evaluation for SMEs

4.4. Analysis, Interpretation, and Report

Specific industries of SMEs which should implement environmental performance evaluation were identified throughout the analysis and interpretation of the distribution of the industries evaluating and reporting environmental performance indicators. Indicators which such industries might need were identified and interpreted.

Indicators used in several environmental performance evaluation guidelines and standards were compared to analyze and interpret whether SMEs could apply to them. The results of indicators used in this survey were also analyzed and interpreted in accordance with these guidelines. Eco-efficiency indicators were reviewed in order to interpret and report a small or medium company's sustainability

To identify the system and method to report environmental performance evaluation in SMEs, reporting elements described in ISO 14031 and other guidelines were reviewed. A few questions were proposed to determine several reporting elements such as scope, audiences or interested parties, time period, and appropriate indicators.

5.0 Analysis and Results

The results of this survey would be used towards developing substantial and simplistic EPIs, such as Management Performance Indicators (MPIs), Operational Performance Indicators (OPIs), which are available to small or medium sized companies in limited industrial sectors.

The data identified and analyzed for this thesis were taken from forty members of GEMI and twelve companies which reported their environmental performance report in accordance with guidelines of Global Reporting Initiative (GRI). The surveyed companies are presented in Table 5. The following elements are the limitations of this survey:

- All sampled companies have implemented Environmental Management Systems, reported environmental performance, and are global or large companies;
- Data were collected from the Internet and published reports (Appendix 2);
- Data described in each environmental report was not verified beyond the initial screening, nor was the EPE or reporting procedures identified or evaluated for suitability or effectiveness;
- Data were collected from environmental reports disclosed during 1999 through 2002;
- Some of the sampled companies had followed the standards of both GEMI and GRI related to EPE, because they are members of both institutions;
- Selected indicators for this survey, such as management performance indicators and operating performance indicators, were used as environmental performance indicators for sustainability as described in GRI and ISO 14031;
- The North American Industry Classification System (NAICS) was used to classify types of industries for this thesis. NAICS is used throughout the world. The classification systems of U.S. (1987 SIC), Canada (1980 SIC) and Mexico (1994 Mexican Classification of Actives and Products (CMAP) were replaced by the NAICS;
- Because most companies were conglomerates, NAICS code of their representative industry was used to classify type of industry;

- Economic and social performances of sample companies were considered when they were mentioned in environmental performance reports, and others such as sustainability report, environmental notice, and GRI reports; and
- Some of the sampled companies did not disclose the environmental performance indicators in their environmental reports. However, the result of this survey cannot conclusively verify that they had not used such performance indicators. They might have assessed them through other methods according to their characteristics and conditions, or they might have not addressed them in their report because of several reasons such as verification, credibility, and confidence.

5.1 Environmental Performance Reports in several industrial fields

In order to identify trends of EPE and the kinds of environmental indicators they were using, sample companies were classified according to types of industry.

The North American Industry Classification System (NAICS) was used to classify types of industry for this thesis. NAICS is used throughout the world. In July 1994, the classification systems of U.S. (1987 SIC), Canada (1980 SIC) and Mexico (1994 Mexican Classification of Actives and Products (CMAP) were replaced by NAICS. NAICS has a six-digit coding system to classify each particular industry. The first two digits of the NAICS denote the sectors that represent general categories of economic activities. The third digit denotes the sub-sector, the fourth digit denotes the industry group, the fifth digit denotes the NAICS industry, and the sixth digit denotes the national industry. The third digit and fourth digit for this thesis were used to classify industry groups. This is due to the fact that they are generally used as for higher level of detail rather than the detailed industry used by the United States, Canada, and Mexico, which participated to make this system.

Sample companies were classified in accordance with the third digit. Specially, the chemical manufacturing industry was separated according to the fourth digit, because chemical manufacturing companies were a majority in the sample companies and their environmental characteristics differed dependent upon their products, activities and services.

However, it was very difficult to classify sample companies in accordance with NAICS because most companies were conglomerates. Most of them had different codes of NAICS. Accordingly, NAICS code of their representative industry was used to classify type of industry for this thesis. The industry with the highest revenue in the report year was defined as a representative industry. For example, 3M has diverse industries, such as, transportation, health care, industry, and graphics and safety markets. Although the net sales of transportation, graphics and safety markets were $3,526 million in 2001, these values combined by several industries. When net sales of each industry were considered, health care industry showed the highest net sales, $3,419 million (http://media.corporate-ir.net/media_files/NYS/MMM/reports/3m_01ar.pdf). Therefore, 3M was categorized into the chemical manufacturing sector, NAICS code of 325, for this thesis. NACICS code for samples companies are included Table 5.

	No	Company name	NAICS	Main Products
G E M I	1	3M	325	Chemical Manufacturing
	2	Abbott Laboratories	325	Chemical Manufacturing
	3	Anheuser-Busch Inc	312	Beverage and Tobacco Product Manufacturing
	4	Ashland Inc	237	Heavy and Civil Engineering Construction
	5	Aventis Pharmaceuticals Inc.	325	Chemical Manufacturing
	6	Bristol-Myers Squibb Company	325	Chemical Manufacturing
	7	Burlington Northern Santa Fe Railway	482	Rail Transportation
	8	The Coca-Cola Company	312	Beverage and Tobacco Product Manufacturing
	9	ConAgra Foods	311	Food Manufacturing
	10	Dell Computer Corporation	334	Computer and Electronic Product Manufacturing
	11	The Dow Chemical company	325	Chemical Manufacturing
	12	Duke Energy	221	Utilities

Table 5 – NACIS Code of Sample Companies

	No	Company name	NAICS	Main Products
G E M I	13	Dupont	325	Chemical Manufacturing
	14	Eastman Kodak Company	325	Chemical Manufacturing
	15	Eli Lilly and Company	325	Chemical Manufacturing
	16	FedEx	491	Postal Service
	17	Georgia-Pacific Corporation	322	Paper Manufacturing
	18	The Goodyear Tire& Rubber Company	326	Plastics and Rubber Products Manufacturing
	19	Halliburton Company	324	Petroleum and coal Products Manufacturing
	20	Hewlett Packard Company	334	Computer and Electronic Product Manufacturing
	21	Hoffmann-La Roche	325	Chemical Manufacturing
	22	Intel Corporation	334	Computer and Electronic Product Manufacturing
	23	Johnson & Johnson	325	Chemical Manufacturing
	24	Johnson Controls Inc.	531	Real Estate
	25	Koch Industries, Inc.	324	Petroleum and coal Products Manufacturing
	26	Lockheed Martin Corporation	336	Transportation Equipment Manufacturing (3364)
	27	Merck & Co., Inc.	325	Chemical Manufacturing
	28	Mirant Corporation	221	Utilities
	29	Motorola, Inc.	334	Computer and Electronic Product Manufacturing
	30	Novartis Corporation	325	Chemical Manufacturing
	31	Occidental Petroleum Corporation	324	Petroleum and coal Products Manufacturing
	32	Pfizer Inc	325	Chemical Manufacturing

Table 5 – NACIS Code of Sample Companies

	No	Company name	NAICS	Main Products
G E M I	33	Philips Morris Company	334	Computer and Electronic Product Manufacturing
	34	The Procter & Gamble Company	325	Chemical Manufacturing
	35	Schering-Plough Corporation	325	Chemical Manufacturing
	36	Smithfield Foods, Inc	311	Food Manufacturing
	37	Southern Company	221	Utilities
	38	Temple-Inland Inc.	321	Wood Product Manufacturing
	39	Texas Instruments Incorporated	334	Computer and Electronic Product Manufacturing
	40	Wyeth	325	Chemical Manufacturing
G R I	41	Polaroid	325	Chemical Manufacturing
	42	BASF AG	325	Chemical Manufacturing
	43	Baxter International Inc.	325	Chemical Manufacturing
	44	British Airways	481	Air Transportation
	45	Canon	334	Computer and Electronic Product Manufacturing
	46	Danone	311	Food Manufacturing
	47	Ericsson	334	Computer and Electronic Product Manufacturing
	48	General Motor	336	Transportation Equipment Manufacturing
	49	Interface, Inc	314	Textile Product Mills
	50	International Paper	322	Paper Manufacturing
	51	Nokia	334	Computer and Electronic Product Manufacturing
	52	Sunoco	324	Petroleum and coal Products Manufacturing

Table 5 – NACIS Code of Sample Companies

The regular and official environmental performance reports or analogy reports (sustainability reports and independent reports related to environmental actives) in five companies (ConAgra foods, FedEx, Johnson controls, Merck & Co, .Inc, and Schering) could not be found in their respective Internet home sites. They only briefly addressed the results of environmental activities as a type of their company's information.

Other companies, forty-seven in all, had reported regular environmental performance reports with a different report name, since several years ago.

The trend of industries reporting environmental performance from the fifty-two surveys is presented in Table 6. Table 7 illustrates the distribution of Chemical Industry Reporting Environmental Performance. The main companies in chemical industry are Pharmaceutical and medicine manufacturing (3254). This is because such companies may be related to human health, several hazardous materials, and consumer products.

Of them, examples of Basic Chemical Manufacturing (3251) are Petrochemical Manufacturing, Industrial Gas Manufacturing, and Synthetic Organic Dye and Pigment Manufacturing. Printing Ink Manufacturing and Photographic Film, Paper, Plate, and Chemical Manufacturing are examples of Other Chemical Product and Preparation Manufacturing (3259).

Figure 2 illustrates the distribution of industrial groups that reported environmental performances, and Figure 3 is the distribution of NAICS codes in chemical industry. Most environmental performance reports were expressed differently according to the organization's environmental burdens and characteristics, such as types of products, services and activities.

Six industries (Utilities, Food, Beverage and Tobacco Product, Petroleum and Coal Products Manufacturing, Chemical Manufacturing, Computer and Electronic Product Manufacturing) are over 5 % among the member companies of the GEMI. Chemical manufacturing is the highest at 40.0 % of GEMI, and 36.54 % of total sample companies. The reasons why these groups have such high percentages are

- Their activities have very close relationships with their characteristic and environmental aspects or impacts. Accordingly, they have a lot of environmental burdens stemming from their own activities, products, services, and interested parties (such as public, customers, and government);

- Their products (such as energy, oil, and toxic/nontoxic chemicals) might affect significant environmental impacts to nature and to human beings; and
- The public might be interested in their products, especially those electronic products which can be reused, recycled, and reduced.

NO	NACIS	Type of industry	Total(%)	GEMI(%)
1	221	Utilities	3 (5.87)	3 (7.50)
2	237	Heavy and Civil Engineering Construction	1 (1.90)	1 (2.50)
3	311	Food Manufacturing	3 (5.87)	2 (5.00)
4	312	Beverage and Tobacco Product Manufacturing	2 (3.95)	2 (5.00)
5	314	Textile Product Mills	1 (1.90)	
6	321	Wood Product Manufacturing	1 (1.90)	1 (2.50)
7	322	Paper Manufacturing	2 (4.00)	1 (2.50)
8	324	Petroleum and coal Products Manufacturing	4 (7.70)	3 (7.50)
9	325	Chemical Manufacturing	19(36.54)	16 (40.00)
10	326	Plastics and Rubber Products Manufacturing	1 (1.90)	1 (2.50)
11	334	Computer and Electronic Product Manufacturing	9 (17.10)	6 (15.00)
12	336	Transportation Equipment Manufacturing	2 (4.00)	1 (2.50)
13	481	Air Transportation	1 (1.90)	-
14	482	Rail Transportation	1 (1.90)	1 (2.50)
15	491	Postal Service	1 (1.90)	1 (2.50)
16	531	Real Estate	1 (1.90)	1 (2.50)
	total		52	40

Table 6 – Distribution of Industries Field Reporting Environmental Performance

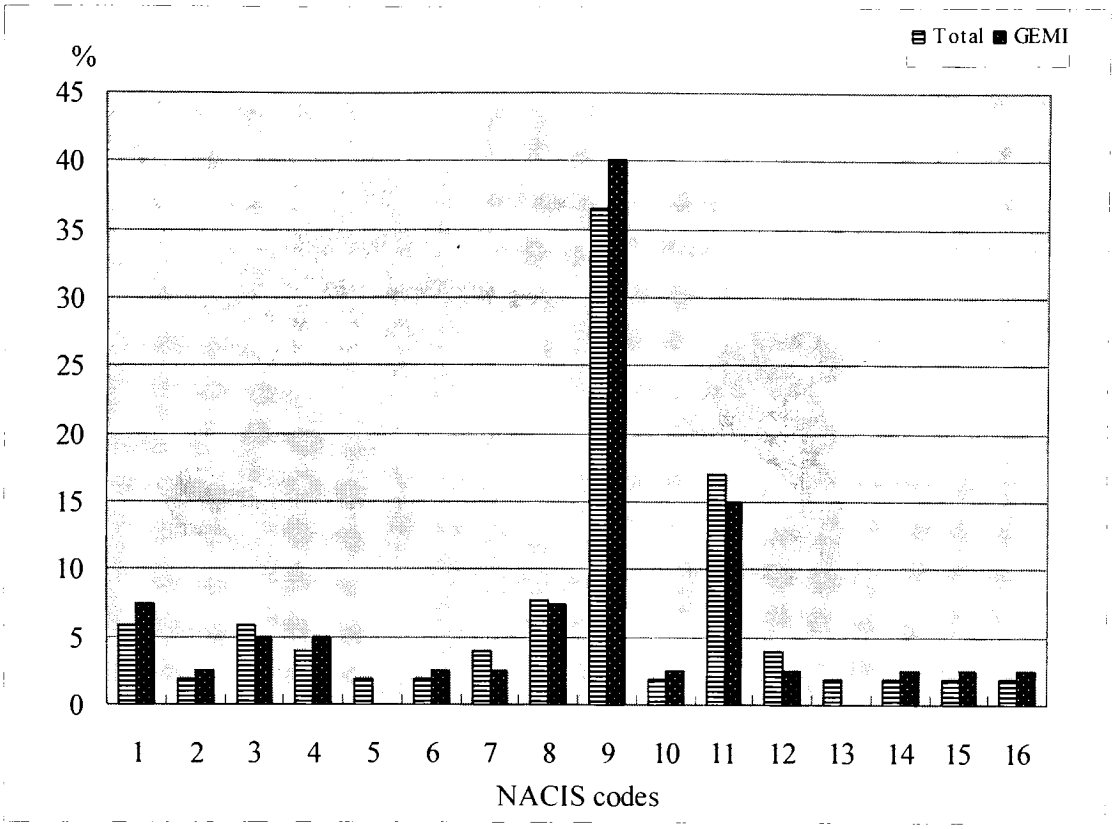

Figure 2 – The distribution of NACIS Codes in Sample Companies

	NACIS	Type of industry	Total(%)	GEMI(%)
1	3251	Basic Chemical Manufacturing	2 (10.53)	3 (7.50)
2	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	1 (5.26)	0 (0)
3	3254	Pharmaceutical and Medicine Manufacturing	12(63.16)	10 (62.50)
4	3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing	3 (15.79)	3 (18.75)
5	3259	Other Chemical Product and Preparation Manufacturing	1 (5.26)	1 (6.25)

Table 7 – The distribution of Chemical Industry Reporting Environmental Performance

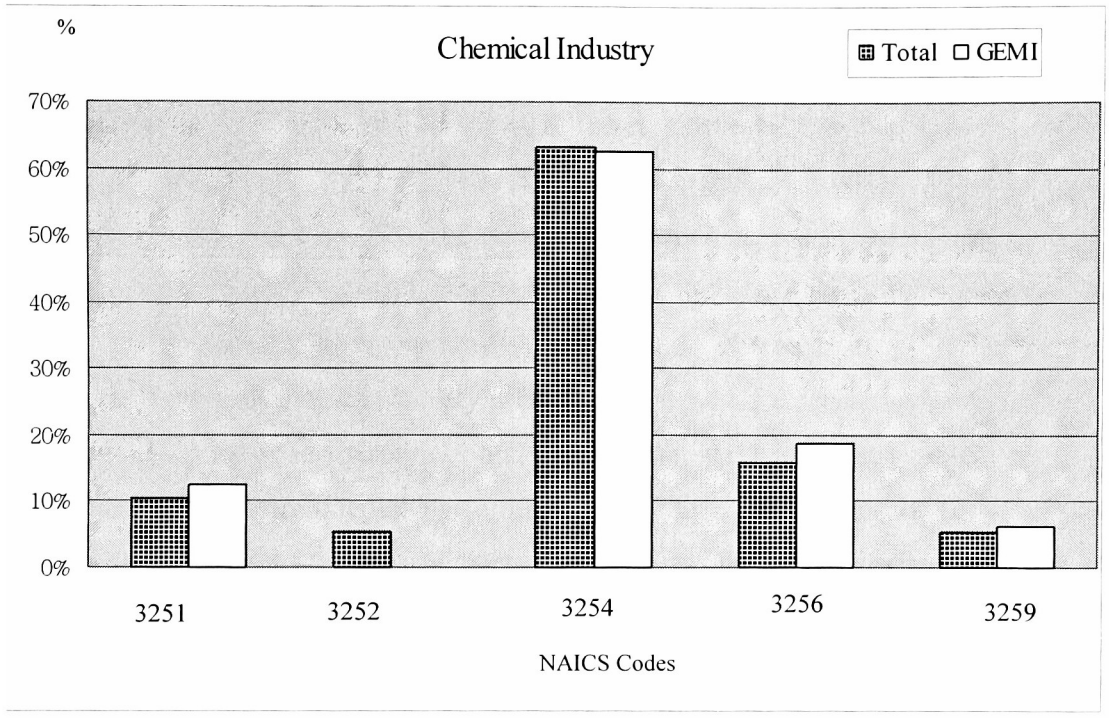

Figure 3 – The distribution of NACIS Codes in Chemical Industry

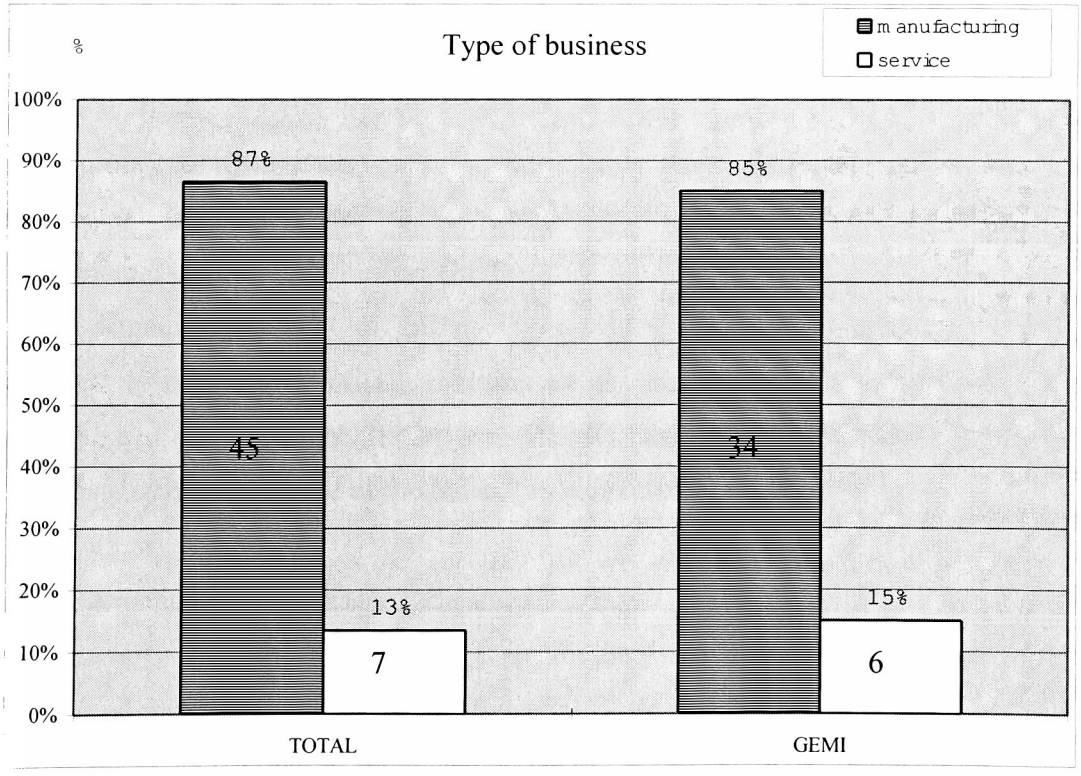

Figure 4 - Type of Business

To identify the trend of industry groups with environmental performance reports, focus was placed on members of GEMI rather than on all of the sampled companies. Because all the companies who are members of GEMI were surveyed for this thesis, focus on GEMI members was chosen. Most of the surveyed companies, thirty-four companies, are from the manufacturing industry. The remaining companies, Burlington Northern Santa Fe Railway, FedEx, and Johnson Controls are service industries (utilities, transportation, postal, and real estate industry group). The common characteristic of these service industry groups is that they are closely related to energy. If a service industry shows a close relationship between its services and energy, that service industry should evaluate and disclose their environmental performance according to the type of their service; because, energy is one of the most important concerns of the global environment. Figure 4 illustrates the type of business.

The distribution of countries to environmental performance reports was not addressed in this thesis because most of the companies in the sample were global companies and the results of environmental activities of each branch country local were reported in same reports.

5.2 Characteristic of EPIs in several industrial groups

A number of indicators used for this thesis were separated into Management Performance Indicators (MPIs), Operation Performance Indicators (OPIs), and Environmental Condition Indicators (ECIs).

The detailed indicators of MPIs, OPIs, and ECIs were selected from diverse references, such as, ISO 14031, Environmental Self assessment program by Global Environmental Management Initiatives (GEMI), and guidelines of Global Reports Initiatives (GRI). Also, some of the indicators were created for this thesis.

5.2.1 Management Performance Indicators (MPIs)

Examples of MPIs in ISO 14031 are divided into four areas: implementation of policies and programs, conformance, financial performance, and community relations. Other performance reports and evaluation systems (i.e., guidelines of GRI and environmental self-assessment program of GEMI), were not distributed among special

performance indicators like MPIs, OPIs, ECIs, as explained in ISO 14031. Such performance evaluation systems mention general elements related to environmental management, such as, integrated management, process improvement, financial and social performance, and emergency preparedness. The detailed discussion about the guidelines of GRI and environmental self-assessment program of GEMI will be addressed later in chapter 6.

Small and medium companies might not understand the concepts of management performance related to environmental activities, products, and services, because they might not have experienced enough environmental management. They might be accustomed to not source management but end-of pipe control. The list and results of MPIs selected and surveyed for this research are presented in Table 8. These indicators were selected from ISO 14031, GRI, and GEMI. Figure 5 shows the distribution of MPIs of the sample companies.

Net sales and number of employees were mainly used as general business indicators in environmental performance reports. Most of the sample companies implemented Environmental Management System (EMS). Of those who implemented EMS, ISO 14001 was mainly adopted because this was the prevalently acknowledged international environmental management standard published and reviewed by the International Organization for Standards (ISO). EMAS is the local environmental management system for an organization in the European Union and other EMSs that an organization had established according to its characteristics such as region, type of business, request of customers, and vision of the organization were properly implemented in each company. The date used to implement Design for Environment (DfE) and Life Cycle Assessment (LCA) as environmental tools were used to evaluate and report an organization's environmental performance.

5.2.1.1 The Most Useful and Least Useful Indicators

The number of management indicators used over the average (61 %) of the environmental performance reports of sample companies is 16 (67 %). The five most useful indicators in the sampled companies are presented in Table 9. Two indicators with 90.38% among them are related to external management activities, and other three

No	Indicators	The result of survey	Percent
1	Business general indicators used in environmental performance reports, e.g.: mass of product sold; net sales and gross margin; characteristic of the organization such as number of employees, size, and products	39	75.00%
2	Whether ISO 14001, EMAS or other management systems are in place, e.g.: ISO 14001, EMAS, and Others	43	82.69%
3	Whether using several environmental management tools, e.g.: -Design for Environmental (DfE), Life Cycle Assessment (LCA), Environmental accounting, and Eco-label	34	65.38%
4	Which standard is being followed or considered for environmental performance evaluation and disclosure, e.g.: ISO 14031; GRI; and Independent standard/ procedure	40	76.92%
5	Only Environmental performance, including in performance evaluation and reporting:	5	9.62%
6	Environmental, health and safety performance, including in performance evaluation and reporting:	33	63.46%
7	Environmental, health, safety performance, and others such as economical and social development and performance, including performance evaluation and reporting:	14	26.92%
8	Whether companies participate in volunteer activities	47	90.38%
9	Whether companies have employee awards for exemplary performance	15	28.85%
10	Whether companies have verification of environmental performance or performance reports (third or self – verification/certification)	12	23.08%
11	Performance trends over time	32	61.54%
12	Sustainability: economic performance, e.g.: financial performance such as net profit, income - investment performance	29	55.77%

Table 8 Management Performance Indicators (MPIs) of the Sample Companies

No	Indicators	The result of survey	Percent
13	Sustainability: social performance. e.g.: -per worker health and safety investment for illness and injury prevention; ratio of training budget to annual operation costs	40	76.92%
14	Environmental cost (including avoided costs)	29	55.77%
15	Whether environmental performance evaluation is used as a decision-making tool	32	61.54%
16	Extent to which environmental objectives and targets are met	13	25.00%
17	Degree of conformance with regulation, e.g.: -number of compliance with regulation; costs attributable to fines and penalties	44	84.62%
18	Community relations. E.g.: -number of inquiries or comments about environmentally related matters; number of sites with environmental report	47	90.38%
19	Whether an organization integrates EMS into other management systems such as business, quality management system, and health and safety management system.	45	86.54%
20	Whether an organization educates, trains and encourages employees to perform their activities in an environmentally sound manner or written procedures	41	78.85%
21	Whether an organization has a system to develop and provide products or services that have environmentally friendly impacts and are safe	34	65.38%
22	Whether an organization conduct or provide research on the environmental impacts of raw materials, products, processes, and emissions related to its activities, products and services	40	76.92%
23	Support provided to contractors and suppliers to carry out environmentally friendly activities such as EMS	36	69.23%
24	Whether an organization develop and maintain (significant environmental aspects and impacts) emergency preparedness plans in accordance with its characteristics such as emergency services, local community, potential hazardous impacts	22	42.31%

Table 8 - Management Performance Indicators (MPIs) of the Sample Companies

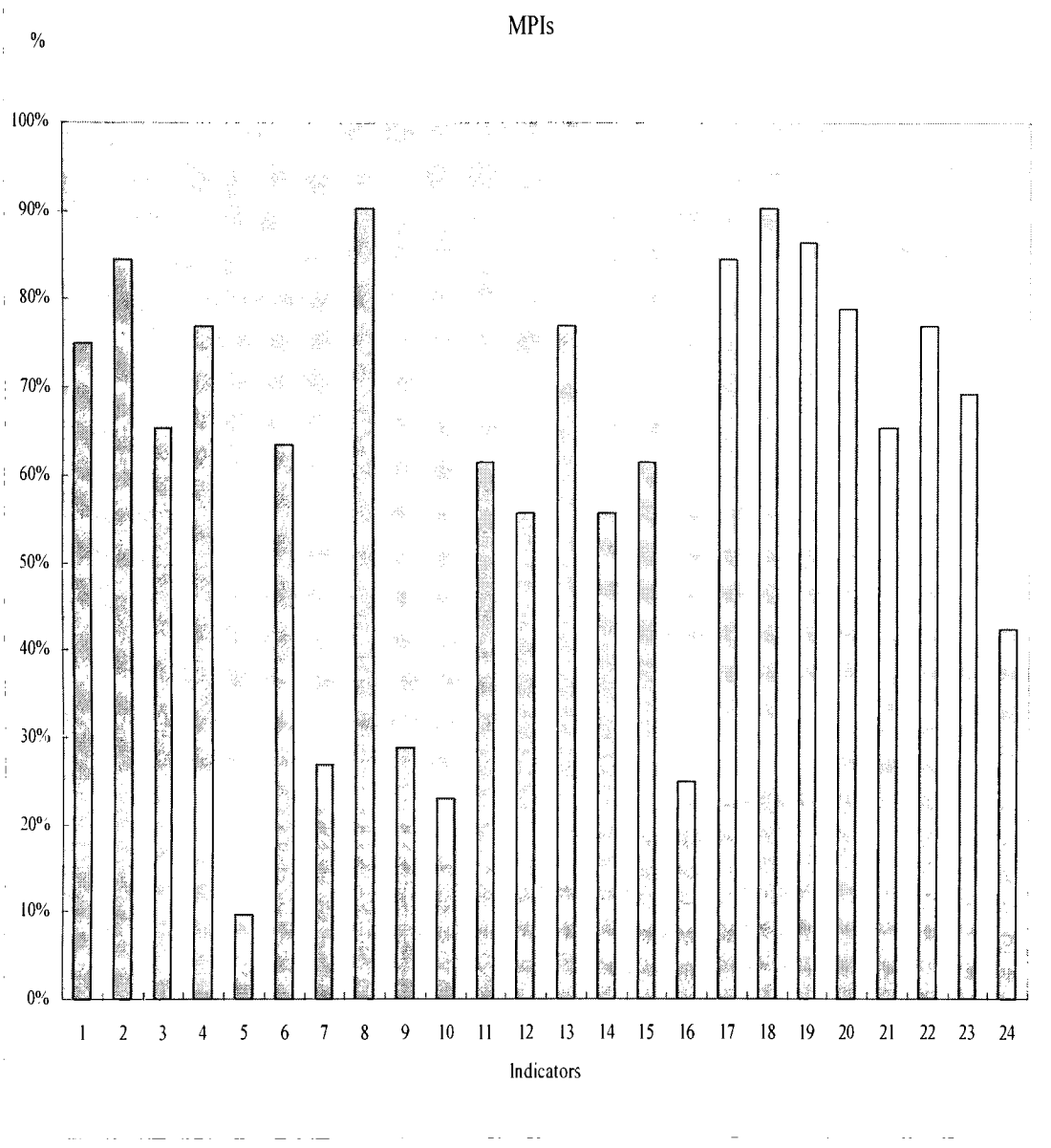

Figure 5 - The distribution of MPIs of the sampled companies

indicators are relevant to internal management activities. This means that many companies focus on management performance indicators related to external interested parties when they report and evaluate their environmental performance.

Continuously, the importance of these external elements will increase because diverse interested parties such as the public, shareholders, government, customers, and neighbors,

are showing great interest. In fact, they are requesting that companies implement environmentally sound activities, products, and services.

No	Indicators	The result of survey	Percent
8	Whether companies participate in volunteer activities	47	90.38%
18	Community relations. e.g.: number of inquiries or comments about environmentally related matters, number of sites with environmental report	47	90.38%
19	Whether an organization integrates EMS into other management systems such as business, quality management system, and health and safety management system.	45	86.54%
17	Degree of conformance with regulation, e.g.: -number of compliance with regulation; costs attributable to fines and penalties	44	84.62%
2	Whether ISO 14001, EMAS or other management systems are in place	43	82.69%

Table 9 The Most Useful Five MPIs among Samples

Companies have also reported diverse internal management indicators, such as, integration of environmental management with other management systems, degree of conformance with regulation, and third party certifications relevant to environmental management system as key indicators for management performance.

The five lowest management indicators are presented in table 10. Indicator No 5 showed the lowest percentage in 24 MPIs and may mean that they evaluate and report environmental performance indicators as well as other indicators, such as, health and safety performance indicators. In addition, many companies recently evaluated and reported their economic and social performance after GRI published its guideline for sustainability reporting.

There is supporting evidence that a system or regulation to verify diverse and volunteer environmental performance reports has not been established publicly. Environmental institutions like GRI and GEMI have published only guidelines and

No	Indicators	The result of survey	Percent
5	Only Environmental performance, including in performance evaluation and reporting:	5	9.62%
10	Whether companies have verification of environmental performance or performance reports (third or self – verification/certification)	12	23.08%
16	Extent to which environmental objectives and targets are met	13	25.00%
9	Whether companies have employee awards for exemplary performance	15	28.85%
24	Whether an organization develop and maintain (significant environmental aspects and impacts) emergency preparedness plans in accordance with its characteristics such as emergency services, local community, potential hazardous impacts	22	42.31%

Table 10 - The Five Lowest MPIs among Sample

examples of environmental performance reports. Even though a company verifies its environmental performance, it might be contested because of questionable reliability of diverse performance data and suitability on the system. The tools to select, collect, and analyze performance indicators might not have been recognized by some interested parties. In other words, diverse performance indicators could have been set up differently in accordance to an organization's characteristics and concerns. Accordingly, sample companies might not have used indicator No 10.

Since 82.69 % of the sample companies had implemented environmental management systems similar to ISO 14001 and EMAS, they might establish and carry out environmental objectives and targets, which is one of the requirements of such regulation. However, only 13 companies (25% of all companies), evaluated and reported performance regarding environmental objectives and targets. In spite of designating and accomplishing environmental objectives and targets, sometimes the companies might not report them.

The indicator for employee's awards to environmental accomplishment yielded a surprisingly low percentage of 28.8 %. Because sample companies were large, global

companies, it was expected that they might have awards system to motivate their employees to follow their environmentally friendly activities and procedures.

5.2.1.2 MPIs in Particular Industry Groups

This chapter will show indicators used more than 5 % of the sampled companies. Industry groups over 5 % in Figure 2 consists of six groups: Utilities (221), Food Manufacturing (311), Beverage and Tobacco Product Manufacturing (312), Petroleum and Coal Products Manufacturing (324), Chemical Manufacturing (325), and Computer and Electronic Product Manufacturing (334). The MPIs used in each industry groups were different due to their industry specific characteristics, such as, environmental activities, products, and services.

Utilities (221)

Figure 6 illustrates the management performance indicators in utilities industry. MPIs used over 53 % of indicators in this industry are

- Business general indicators such as net sales, the number of employees. (1)
- Environmental management systems; for example, ISO 14001, and EMAS. (2)
- Standard related to environmental performance evaluation and disclosure. (4)
- Environmental, health and safety performance. (6)
- Participation of volunteer activities. (8)
- Sustainability: economic performance such as margin. (12)
- Sustainability: social performance such as illness and injuries rate. (13)
- Degree of conformance with regulation; for example, number of compliance with regulation and costs attributable to fines and penalties. (17)
- Community relations; for example, number if inquires or comments about environmentally related matters and number of sites with environmental reports (18)
- Integration of EMS with other management systems, such as, business, quality management system, and health and safety management system. (19)
- Education and training for employees' performance. (20)

- Conducting or providing research on the environmental impacts of raw materials, products, and process. (22)
- Supporting contractors and suppliers to carry out environmentally friendly activities such as EMS. (23)

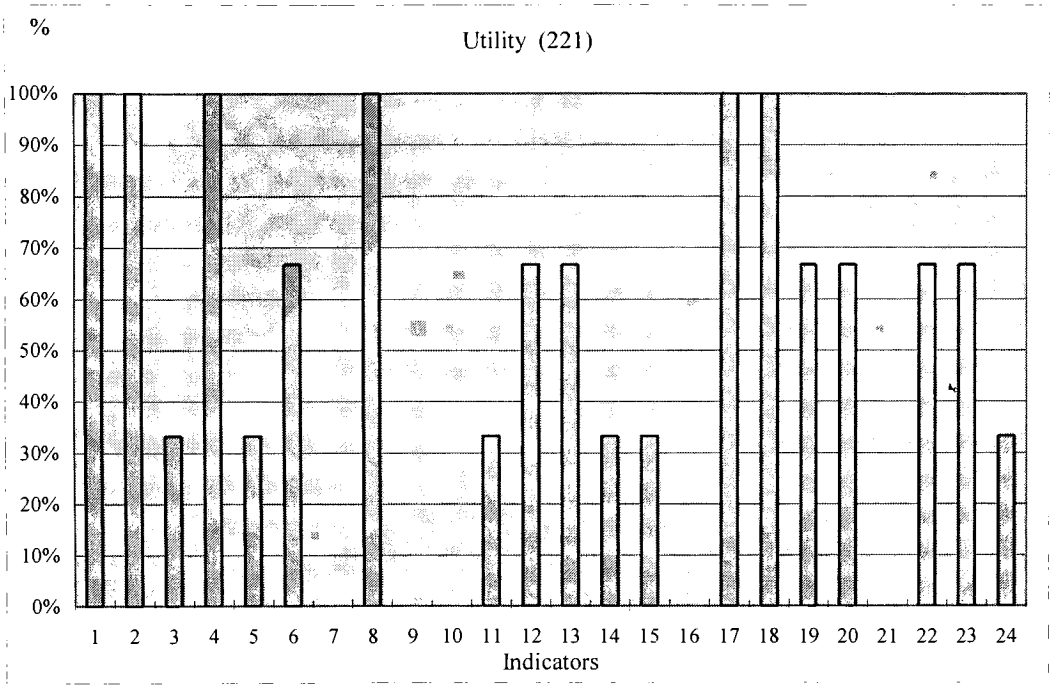

Figure 6 - The Management Performance Indicators (MPIs) in Utilities Industry

Food Manufacturing (311)

Figure 7 illustrates the management performance indicators in food manufacturing industry. MPIs used over 50 % of indicators in this industry are

- Business general indicators; for example, net sales and number of employees. (1)
- Environmental management systems; for example, ISO 14001, and EMAS. (2)
- Several environmental management tools, such as, DfE, LCA, and eco-label. (3)
- Standard related to environmental performance evaluation and disclosure. (4)
- Participation of volunteer activities. (8)
- Employee awards for exemplary performance. (9)
- Degree of conformance with regulation; for example, number of compliance with regulation and costs attributable to fines and penalties. (17)

- Community relations; for example, number of inquiries or comments about environmentally related matters and number of sites with environmental report. (18)
- Integration of EMS with other management systems such as business, quality management system, and health and safety management system. (19)
- Education and training for employees' performance. (20)
- Conducting or providing research on the environmental impacts of raw materials, products, and process. (22)
- Supporting contractors and suppliers to carry out environmentally friendly activities such as EMS. (23)

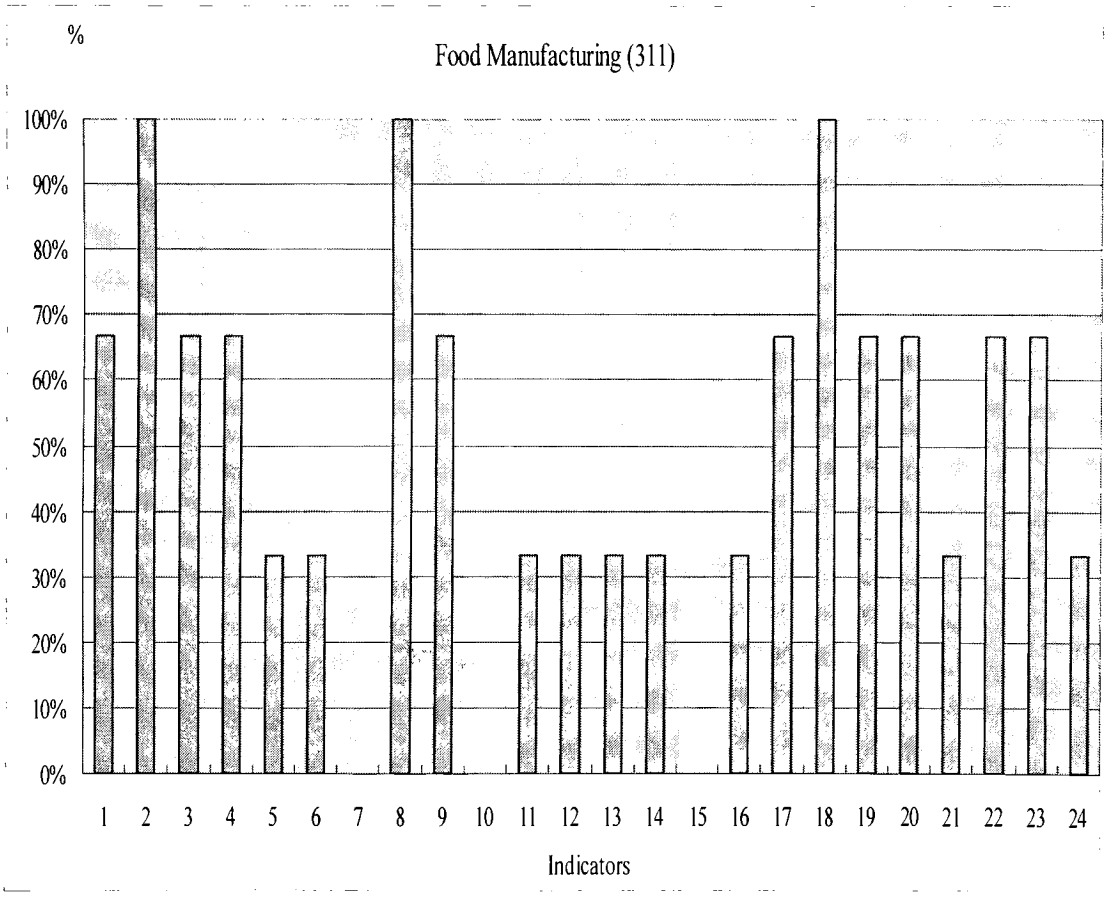

Figure 7 The Management Performance Indicators (MPIs) in Food Manufacturing

Indicators No 2, 8, and 18 (management activities related to external interested parties) were used in all companies. Food industry might focus on external environmental

management performance because their products are consumer products and are closely related to diverse interested parties.

Beverage and Tobacco Product Manufacturing (312)

Figure 8 illustrates the MPIs in Beverage and Tobacco Product Manufacturing. MPIs used over 67 % of indicators in this industry are indicator No 7, 8, 14, 15, 17, 18, 19, 20, 21, 23, and 24. Since two companies were surveyed, it might not be easy to analyze MPIs for this industry.

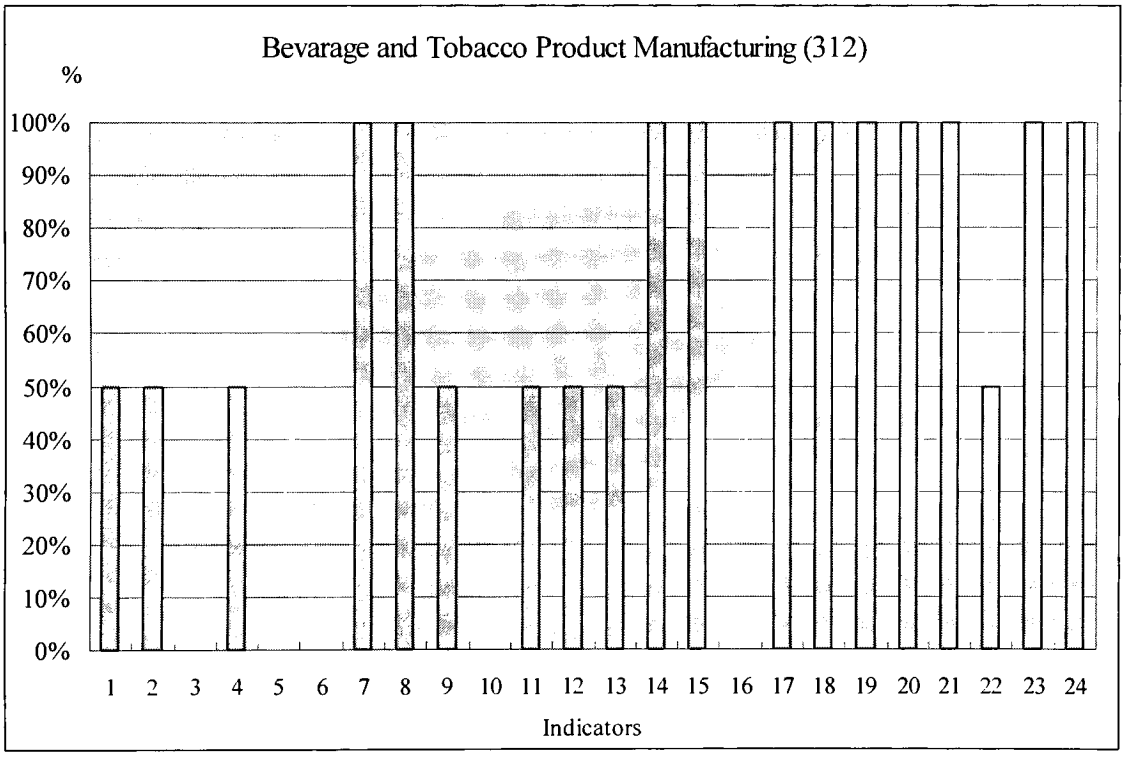

Figure 8 - The Management Performance Indicators (MPIs) in Beverage and Tobacco Product Manufacturing

Petroleum and Coal Products Manufacturing (324)

Figure 9 illustrates the MPIs in Petroleum and Coal Products Manufacturing. MPIs used over 61 % of indicators in this industry are

- Environmental management systems; for example, ISO 14001, and EMAS. (2)
- Several environmental management tools, such as, DfE, LCA, and eco-label. (3)

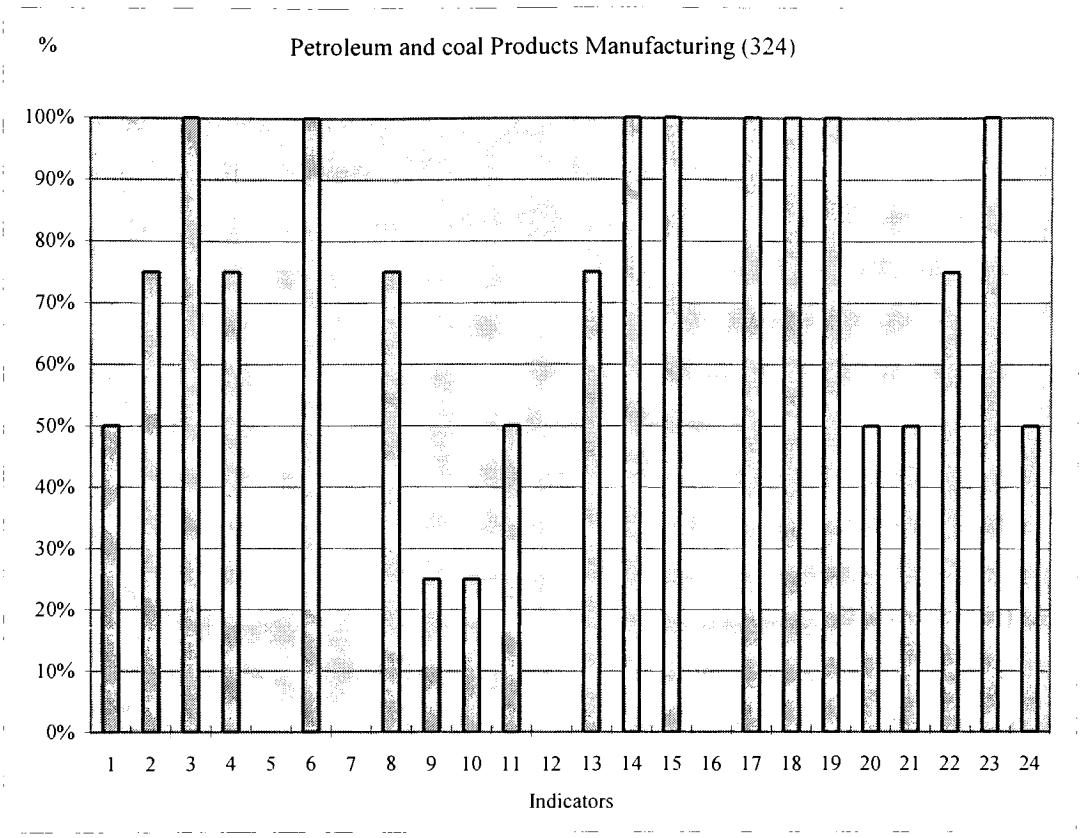

Figure 9 - The Management Performance Indicators (MPIs)in Petroleum and Coal Products Manufacturing.

- Standard related to environmental performance evaluation and disclosure. (4)
- Environmental, health and safety performance. (6)
- Participation of volunteer activities. (8)
- Sustainability: social performance, such as, illness and injuries rate. (13)
- Environmental costs (including avoided costs). (14)
- Whether environmental performance evaluation is used as a decision-making tool. (15)
- Degree of conformance with regulation; for example, number of compliance with regulation and costs attributable to fines and penalties. (17)
- Community relations; for example, number of inquiries or comments about environmentally related matters and number of sites with environmental report. (18)

- Integration of EMS with other management systems such as business, quality management system, and health and safety management system. (19)
- Conducting or providing research on the environmental impacts of raw materials, products, and process. (22)
- Supporting contractors and suppliers to carry out environmentally friendly activities such as EMS. (23)

Indicators No 3, 6, 14, 15, 17, 18, 19, and 23 were used in all of the Petroleum and Coal Products Manufacturing companies. Indicators 5 (Only Environmental performance, including in performance evaluation and reporting); 7 (Environmental, health, safety performance, and others such as economical and social development and performance, including in performance evaluation and reporting); 12 (Sustainability: economic performance); and 16 (Extent to which environmental objectives and targets are met) were not reported in the whole Petroleum and Coal Products industry. Indicators 5 and 7 were not used in the reports because all companies applied environmental, health, and safety performance when they evaluated and report their performance. Even though they did not report economic performance and environmental objectives and targets, they must have managed them because such indicators are fundamental indicators to maintain ISO 14001. Seventy-five percent of the companies addressed that they had certification of ISO 14001 in their environmental performance reports. The indicators used and reported in an organization's environmental report differ from depending on its willingness to implement environmental performance evaluation and characteristics.

Chemical manufacturing (325)

The management performance indicators in Chemical Manufacturing are presented in Figure 10. MPIs used over 69 % of indicators in this industry are

- Business general indicators, such as, net sales and number of employees. (1)
- Environmental management systems; for example, ISO 14001, and EMAS. (2)
- Several environmental management tools, such as, DfE, LCA, and eco-label. (3)
- Standard related to environmental performance evaluation and disclosure. (4)
- Environmental, health and safety performance. (6)
- Participation of volunteer activities. (8)

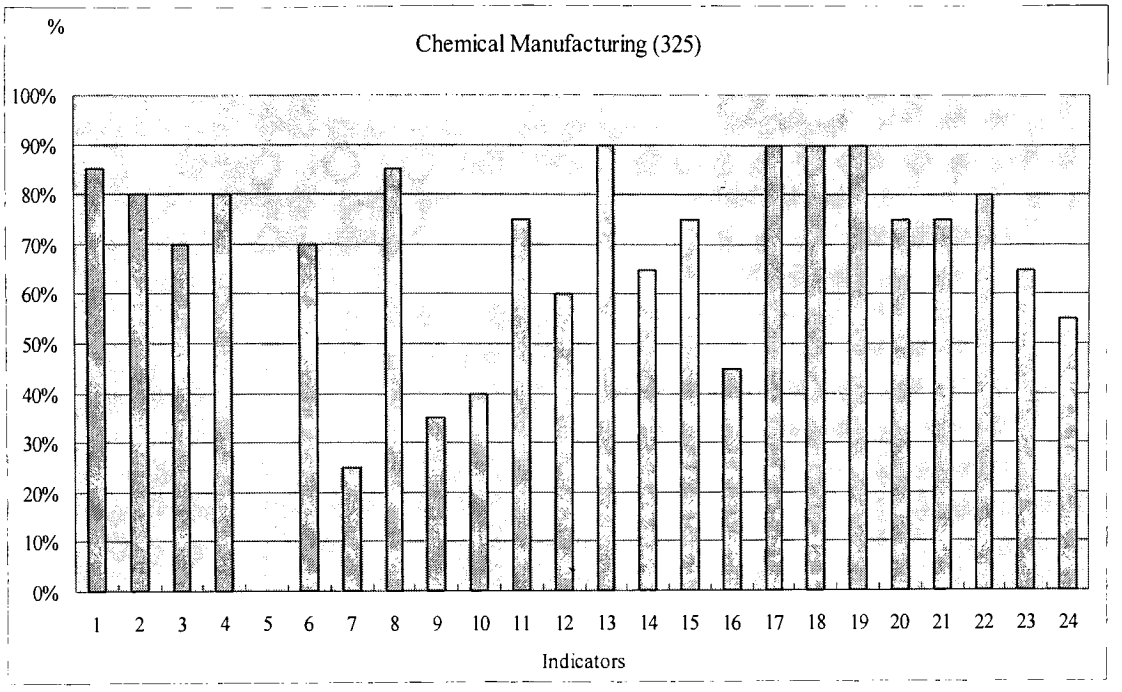

Figure 10 The Management Performance Indicators (MPIs) in Chemical Manufacturing.

- Performance trends over time. (11)
- Sustainability: social performance. (13)
- Whether environmental performance evaluation is used as a decision-making tool. (15)
- Degree of conformance with regulation; for example, number of compliance with regulation and costs attributable to fines and penalties. (17)
- Community relations; for example, number of inquiries or comments about environmentally related matters and number of sites with environmental report. (18)
- Integration of EMS with other management systems such as business, quality management system, and health and safety management system. (19)
- Education and training for employees' performance. (20)
- Developing and providing products or services that have environmentally friendly impacts and are safe. (21)
- Conducting or providing research on the environmental impacts of raw materials, products, and process. (22)

Chemical industry groups evaluated and reported diverse MPIs, because their activities, products, and service have significant environmental impacts. As a result these companies have actively performed environmental and safety management systems. However, they did not include economic and social performance indicators in their environmental reports. Instead, they reported such performance in their annual reports, business and finance reports for financial interested parties, such as shareholders and investors.

Computer and Electronic Product Manufacturing (334).

The management performance indicators in Computer and Electronic Product Manufacturing are showed in Figure 11. MPIs used over 69 % of indicators in this industry are;

- Business general indicators, such as, net sales and number of employees. (1)
- Environmental management systems; for example, ISO 14001, and EMAS. (2)
- Several environmental management tools, such as, DfE, LCA, and eco-label. (3)
- Standard related to environmental performance evaluation and disclosure. (4)
- Participation of volunteer activities. (8)
- Performance trends over time. (11)
- Sustainability: economic performance. (12)
- Degree of conformance with regulation; for example, number of compliance with regulation and costs attributable to fines and penalties. (17)
- Community relations; for example, number of inquiries or comments about environmentally related matters and number of sites with environmental report. (18)
- Integration of EMS with other management systems, such as, business, quality management system, and health and safety management system. (19)
- Education and training for employees' performance. (20)
- Developing and providing products or services that have environmentally friendly impacts and are safe. (21)
- Conducting or providing research on the environmental impacts of raw materials, products, and processes. (22)

- Supporting contractors and suppliers to carry out environmentally friendly activities such as EMS. (23)

Indicators 2, 8, 17, 19, 20, 21, 22, and 23 were reported in all of the sample companies. Because computer and electronic product industry might have the most international and prevalent market, they might evaluate and report several MPIs in order to apply and advertise their environmentally sound performances.

Eighty-nine percent of them considered Design for Environment (DfE) as environmental management tools to develop and improve their products and management system. This percentage is the highest of the five industry groups above, in terms of environmental management tools. There is fact that they have applied DfE and Life Cycle Assessment so that they might improve and develop new products. A couple of the companies, like HP, also reported product profiles, which are environmental information of their products based on DfE and LCA.

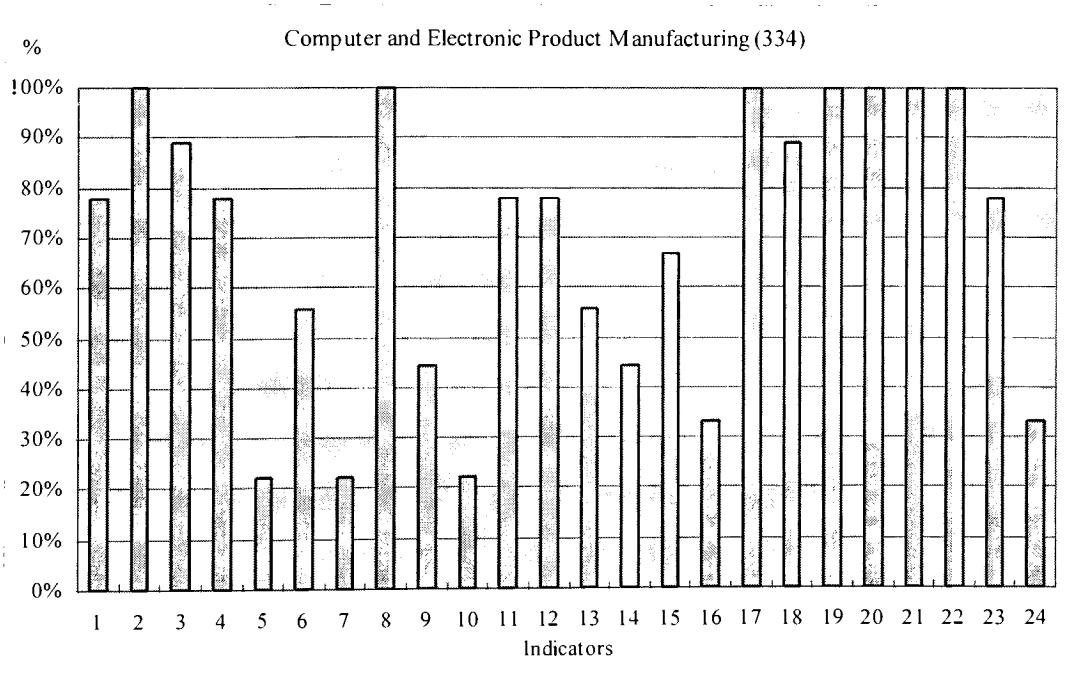

Figure 11 - The Management Performance Indicators (MPIs) in Computer and Electronic Product Manufacturing.

5.3. Operation Performance Indicators (OPIs)

ISO 14031 provides examples of nine elements of operational performance indicators (OPIs): materials, energy, services supporting the organization's operations, physical facilities and equipment, supply and delivery, products, services provided by the organization, wastes, and emissions. These OPIs may be used and evaluated in accordance with an organization's physical facilities and equipment, its products, and its environmental strategy and degree of integration of environment with business elements. Accordingly, OPIs of surveyed sample companies were different, and they did not separate OPIs into nine elements like that of ISO 14031. Operational performance indicators for this thesis were selected from ISO 14031 and the guidelines of GRI and GEMI. Table 11 illustrates the list and results of operational performance indicators surveyed. Most companies reported quantitative and qualitative results of operational performance indicators. Some companies mentioned only what kind of activities they had completed and performed as types of operational performance indicators. As a result, the reports did not explain the degree of performance accomplishments. Qualitative indicators not only give the reader vague information about their environmentally friendly activities, but also give decreased credibility of the data described in the environmental performances reports. The reasons why a company has qualitative performance indicator instead of quantitative indicators might be because they might:

- not have the appropriate indicators in order to report the results
- not know how to establish proper quantitative indicators
- have bad results from indicators, so they might not want to disclose them.
- not know what kind of indicators should be reported

Use of operational performance indicators was not as varied as management performance indicators. Most of the OPIs in the sample companies were similar to each other. That might be because operational indicators for environmentally friendly activities were limited in several targets such as air, waste water, energy, solid waste, and hazardous waste, and materials. Most companies except one, Cannon, reported the total exhausted amount of air and discharge amount of waste water instead of reporting quality of air emission and wastewater like the concentration of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), and dust. Cannon reported the amount of emissions

No	Questions	Total		Quantitative indicators		Qualitative indicators	
		No	%	No	%	No	%
1	Energy consumption/ energy efficiency(e.g. electricity, natural gas, fossil fuel)	46	88	42	91	4	9
2	Material consumption (e.g. raw materials, indirect/ancillary material)	25	48	14	56	11	44
3	Natural Resource consumption (e.g. water, wood, minerals)	39	75	34	87	5	13
4	Eco-efficiency	8	15	6	75	2	25
5	Amount of toxic chemical used and released (including TRI release)	36	69	34	94	2	6
6	Quantity of air emissions and waste water discharges	47	90	44	94	3	6
7	Quantity of hazardous/solid waste generated or disposed	42	81	40	95	2	5
8	Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials	44	85	39	89	5	11
9	Amount of total waste for disposal (landfill/incineration)	28	54	23	82	4	14
10	Air and water quality	1	2	1	100	0	0
11	Number of environmental incidents	32	62	25	78	7	22
12	Degree of noise measured	3	6	3	33	0	0
13	Quantity of packaging waste/quantity of packaging waste per unit of product	27	52	19	70	8	30
14	Development of physical facilities and equipment for recycling, reuse and clean process	37	71	26	70	11	30
15	Decision to design, develop and produce environmentally sound product	41	79	29	71	12	29

Table 11 The List and Results of Operational Performance Indicators (OPIs) Surveyed.

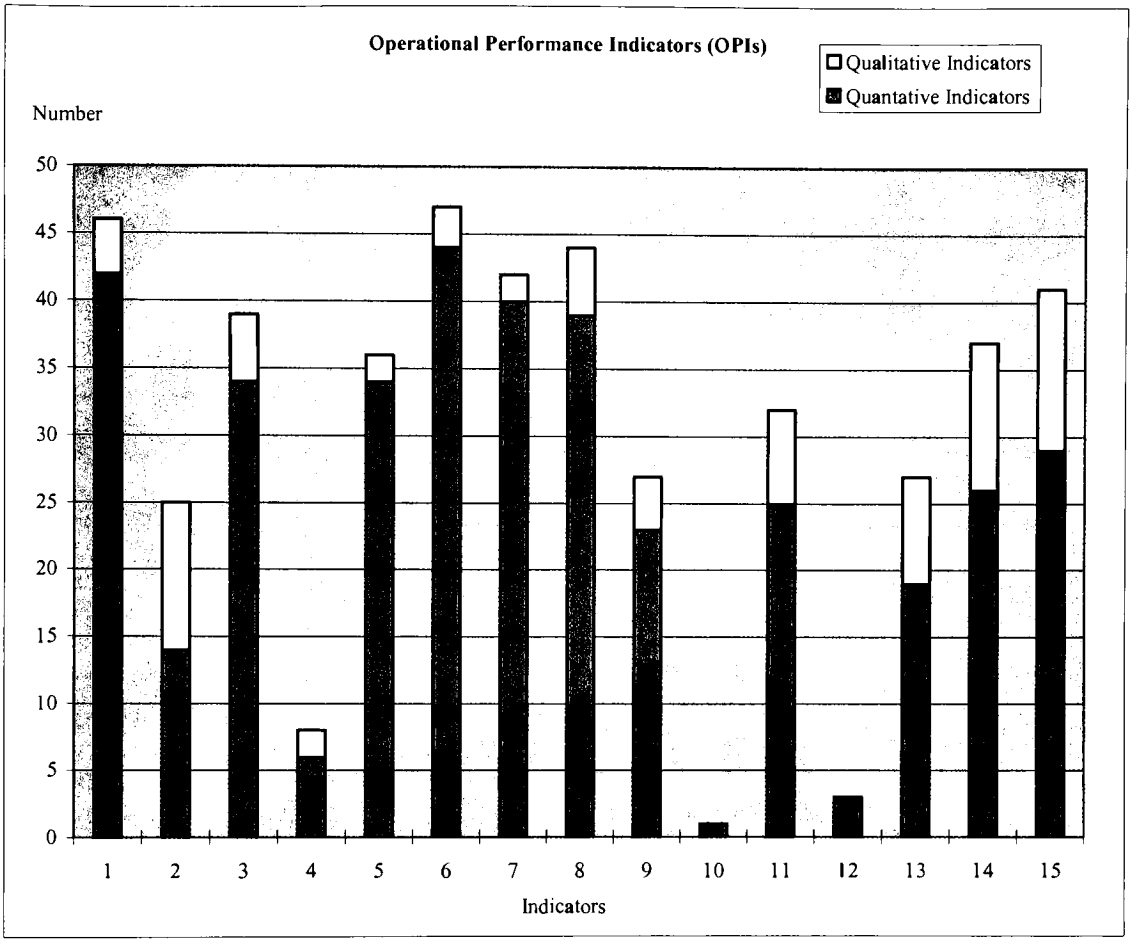

Figure 12 The distribution of Operation Performance Indicators (OPIs)

and discharges as well as the pollutant concentration in air and wastewater. Three companies (FedEx, British Air, and Cannon) evaluated and reported degree of noise in the work-place and around the site area. Among them, FedEx and British Air might measure and track noise because they deal with aircraft, which is one of the biggest causes of noise pollution at their respective sites. It might mean that OPIs could also differ dependent on types of organization's activities, products and services.

The three most useful operational performance indicators in several OPIs were quantity of air emissions and waste water discharges(6), energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1), and amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8). These indicators might be used to evaluate and reports, due to the following reasons:

- the most general environmental activities in several industries
- easy tracking and evaluation in several industries
- easily comprehended by interested parties
- related to regulation
- useful, fundamental data for interpreting other objectives such as eco-efficiency, DfE, and LCA

5.3.1 OPIs in Particular Industry Groups

Figure 12 presents indicators such as energy, amount of air and wastewater, hazardous waste, and solid waste that were commonly used in several industries. However, this chapter will see more specific indicators evaluated and reported in several industry groups.

Utilities Industry (221)

Figure 13 illustrates the indicators of Utilities industry which provides energy such as electronic power, natural gas, and fuel. Operation Performance Indicators used over 56% in this industry were

- Energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1)
- Natural Resource consumption (e.g. water, wood, minerals) (3)
- Amount of toxic chemical used and released (including TRI release) (5)
- Quantity of air emissions and waste water discharges (6)
- Quantity of hazardous/solid waste generated or disposed (7)
- Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8)
- Number of environmental incidents (11)
- Development of physical facilities and equipment for recycling, reuse and clean process (14)
- Decision to design, develop and produce environmentally sound product (15)

Of the above, indicators 5, 6, 7, and 11 were evaluated and reported in all sample companies. This result is due to the fact that utilities industry generates a large amount of pollutants in order to manufacture and sell their products.

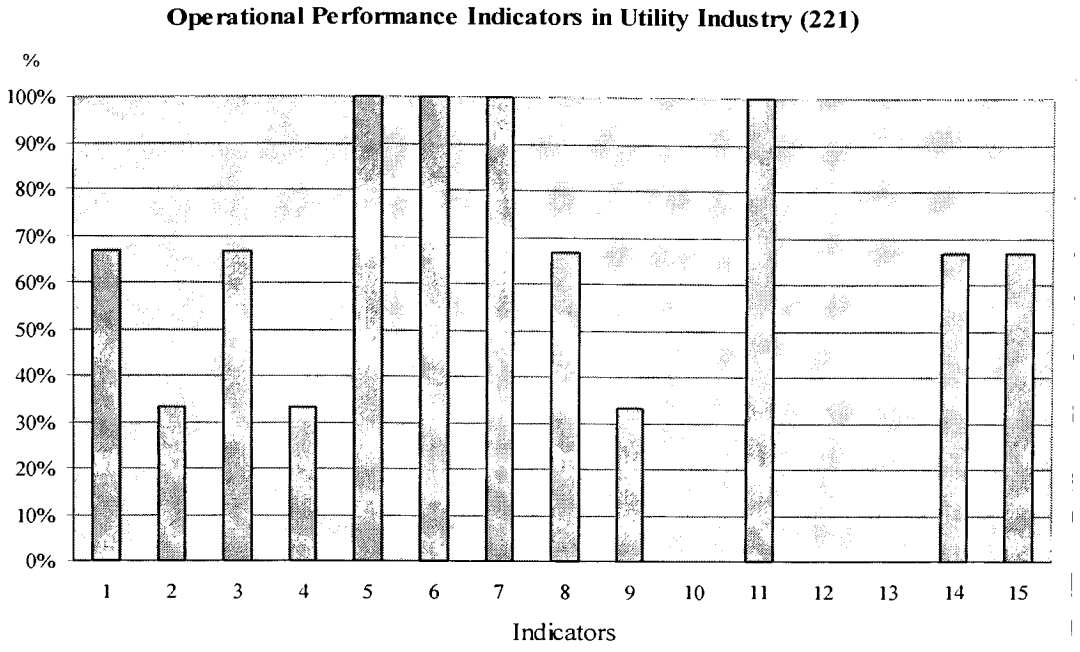

Figure 13 - Operational Performance Indicators (OPIs) in Utilities Industry

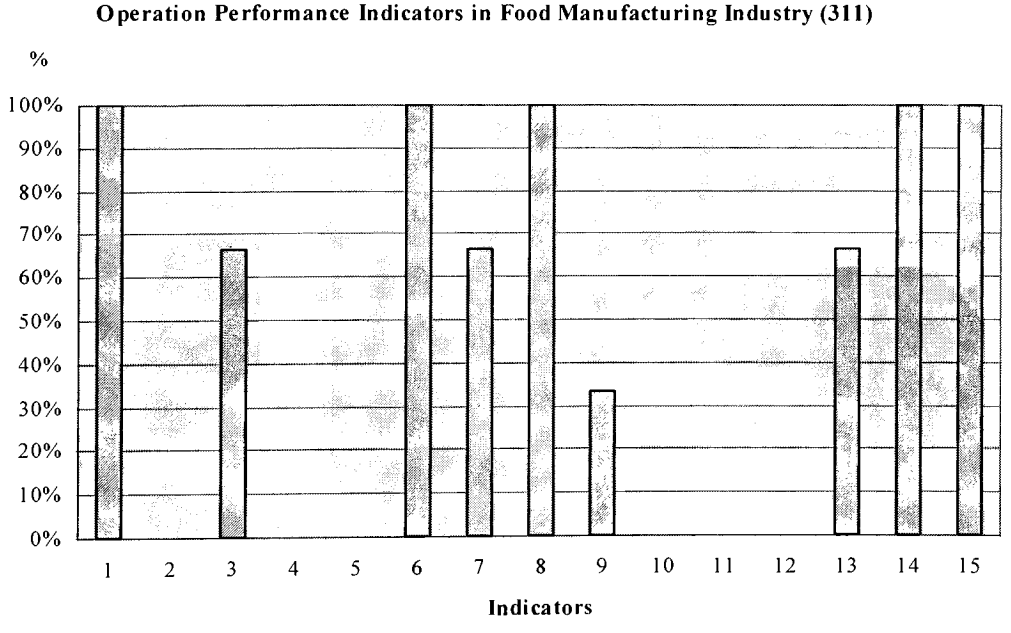

Figure 14 - Operational Performance Indicators (OPIs) in Food Manufacturing

Food Manufacturing Industry (311)

The food manufacturing industry is showed extreme evaluation and reporting of OPIs in Figure 14. Nine of the total sample indicators were reported and five indicators of the nine indicators were reported by 100 %. The five indicators are:

- Energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1)
- Quantity of air emissions and waste water discharges (6)
- Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8)
- Development of physical facilities and equipment for recycling, reuse and cleaning process (14)
- Decision to design, develop and produce environmentally sound products (15).

Through these reported indicators, food companies might seem as though they focused on direct environmental activities. They might use a lot of materials, such as, water, organic materials, and chemicals, to product diverse foods and beverages. Accordingly, they might be interested in significant and natural environmental pollutant like wastewater, energy, and solid waste which may be reused.

Beverage and Tobacco Product Manufacturing (312)

Figure 15 illustrates the MPIs in Beverage and Tobacco Product Manufacturing. Since two companies were surveyed, it might not be easy to analyze OPIs for this industry. OPIs used over 83 % of indicators in this industry are indicator No 1, 3, 5, 6, 7, and 8.

- Energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1)
- Natural Resource consumption (e.g. water, wood, minerals) (3)
- Amount of toxic chemical used and released (including TRI release) (5)
- Quantity of air emissions and waste water discharges (6)
- Quantity of hazardous/solid waste generated or disposed (7)
- Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8)

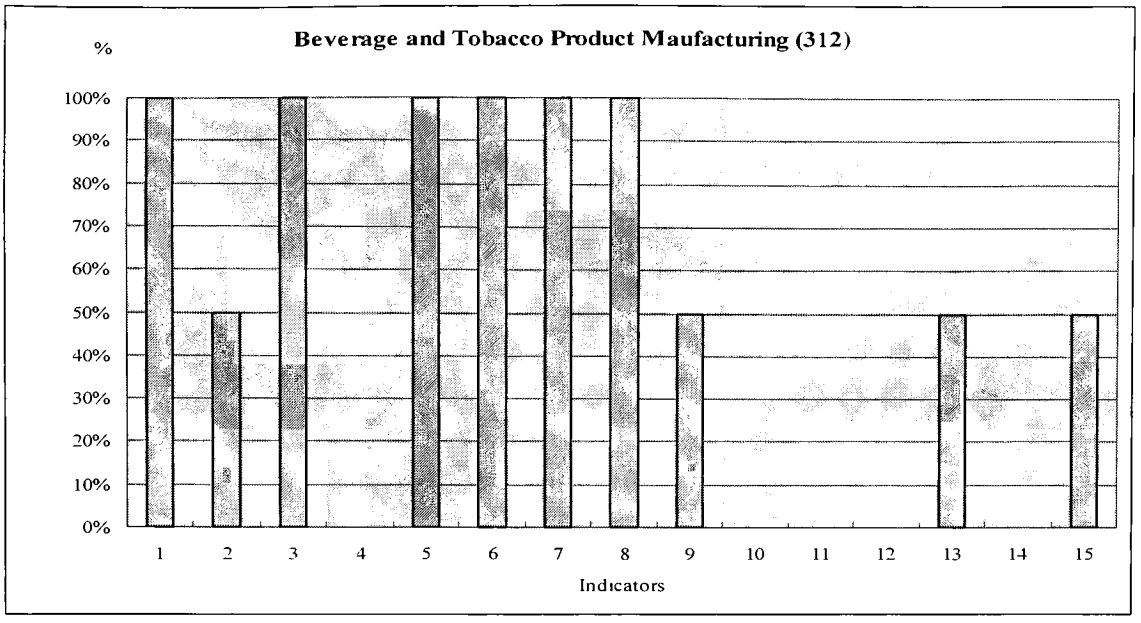

Figure 15 Operational Performance Indicators (OPIs) in Beverage and Tobacco Product Manufacturing

Petroleum and Coal Products Manufacturing Industry (324)

All companies that reported an indicator used one that was related to decision to design, as it may be the most efficient tool for sustainable development. It might address that they had tried to develop and design their products, activities, and services; because their products and resources might be of major environmental and sustainability controversies for all companies and for the public. Figure 16 presents the trends of OPIs of this industry. Indicators using over 47 % of sample companies are

- Energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1)
- Natural Resource consumption (e.g. water, wood, minerals) (3)
- Amount of toxic chemical used and released (including TRI release) (5)
- Quantity of air emissions and waste water discharges (6)
- Quantity of hazardous/solid waste generated or disposed (7)
- Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8)
- Amount of total waste for disposal (landfill/incineration)(9)
- Number of environmental incidents (11)

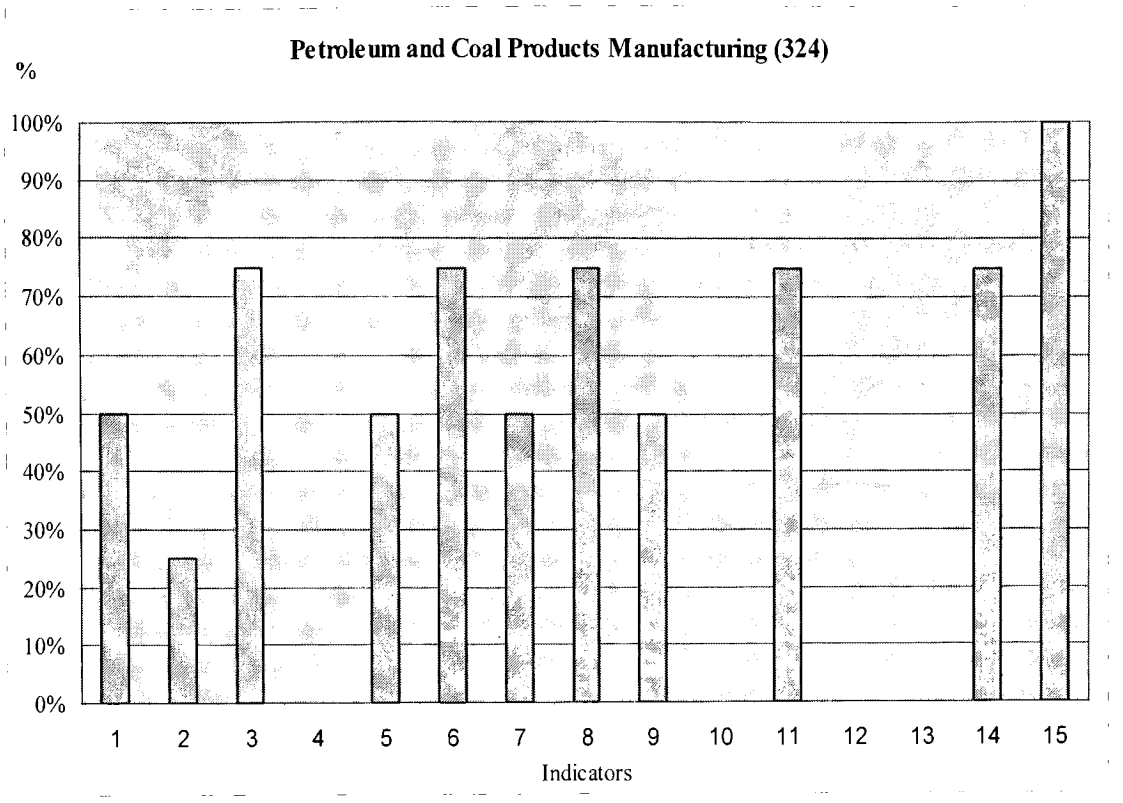

Figure 16 - Operational Performance Indicators (OPIs) in Petroleum and Coal Products Manufacturing

- Development of physical facilities and equipment for recycling, reuse and cleaning process (14)
- Decision to design, develop and produce environmentally sound products (15).

The most particular fact relevant to this survey was that these companies did not report and evaluate eco-efficiency; even though, they had all the elements (such as, sales and energy) needed to evaluate eco-efficiency.

Chemical Manufacturing Industry (325)

It seems as though the OPIs in chemical manufacturing industry are evenly distributed in Figure 17. It means that they not only perform similar environmental operations and activities in similar facilities and similar equipments, but that they also implement similar environmental objectives and target or environmental management system. For example, most chemical manufacturing companies around the world are implementing Responsible

Care (RC), which is the chemical industry's volunteer commitment to the continuous improvement of environmental health and safety performance (http://www.socma.com/responsiblecare/index.htm). RC requires that the company carry out the same requirements if they want to participate in RC standard as ISO 14001. Indicators which were used over 60 % in this industry are:

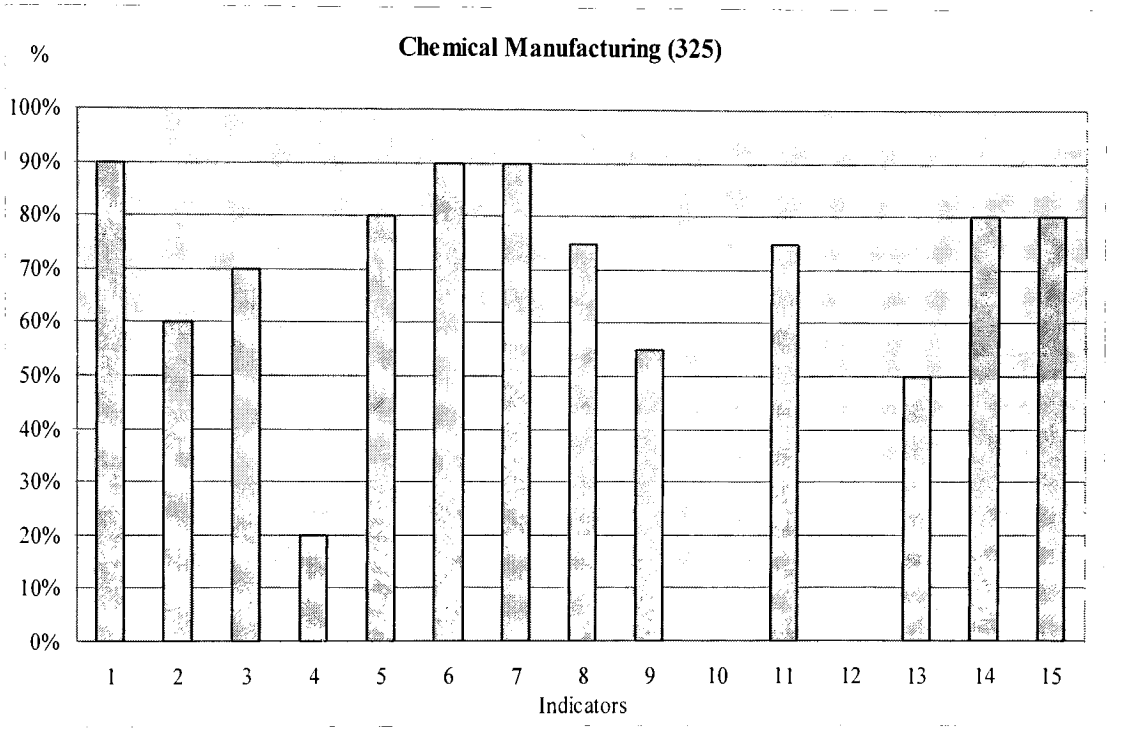

Figure 17 - Operational Performance Indicators (OPIs) in Chemical Manufacturing

- Energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1)
- Natural Resource consumption (e.g. water, wood, minerals) (3)
- Amount of toxic chemical used and released (including TRI release) (5)
- Quantity of air emissions and waste water discharges (6)
- Quantity of hazardous/solid waste generated or disposed (7)
- Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8)
- Number of environmental incidents (11)
- Development of physical facilities and equipment for recycling, reuse and clean process (14)

- Decision to design, develop and produce environmentally sound product (15)

Computer and Electronic Product Manufacturing (334)

The most significant environmental characteristic in this industry may be recyclable, reusable, reduce-able, light, and remanufacturing of products. These products would be called environmentally friendly products, and marketed with third party of eco-labels like energy-star. Interested parties such as customers, stakeholders, government, neighbors, and employees may be very interested in their products, activities, and services because, they deal with these products on a daily basis. Recently, companies, such as Hewlett-Packet (HP) and Cannon, are focusing on recycling and remanufacturing system for parts and body of old-fashioned products. These companies also used operational performance indicators similar to those of the chemical manufacturing industry. Semi-conduct companies around the world have held regular meetings or seminars to prevent, improve, and communicate environmental problems generated by semi-conduct companies. Semi-conductor companies have significant environmental impacts because they must use toxic chemicals like SOx, HCFC, etc. Indicators used over 70 % in this industry are:

- Energy consumption/ energy efficiency (e.g. electricity, natural gas, fossil fuel) (1)
- Natural Resource consumption (e.g. water, wood, minerals) (3)
- Amount of toxic chemical used and released (including TRI release) (5)
- Quantity of air emissions and waste water discharges (6)
- Quantity of hazardous/solid waste generated or disposed (7)
- Amount of reduction, recycling, reuse, and recovering of waste, water, and other materials (8)
- Amount of total waste for disposal (landfill/incineration) (9)
- Quantity of packaging waste/quantity of packaging waste per unit of product (13)
- Development of physical facilities and equipment for recycling, reuse and cleaning process (14)
- Decision to design, develop and produce environmentally sound products (15)

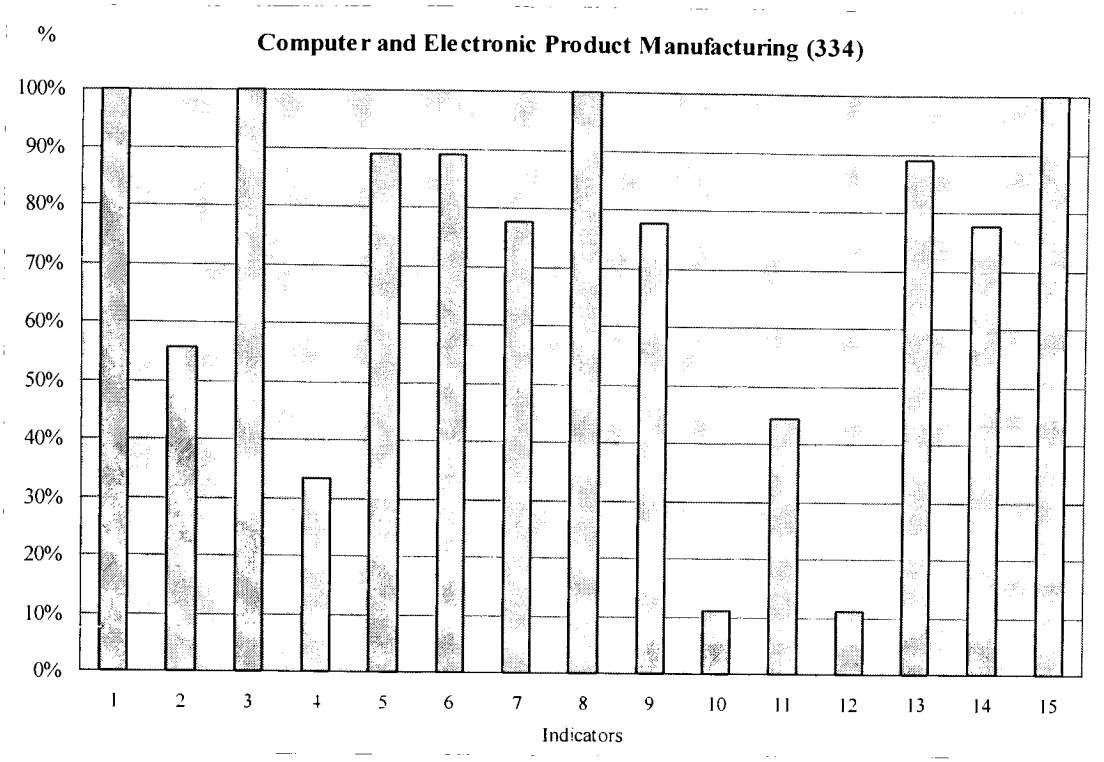

Figure 18 - Operational Performance Indicators (OPIs) in Computer and Electronic Product Manufacturing

5.4. Environmental Condition Indicators (ECIs)

Monitoring and evaluating of the Environmental Condition Indicators (ECIs) may be performed by the local government, international government, non-governmental organization, and scientific institutions. Because ECIs are continuously supported with enough resources such as financial, human resources, and high technical equipment, to assess and report credible data of ECIs, profit or individual organization may have difficulty evaluating environmental condition indicators. The main principal of individual organizations is to be responsible for performing and participating in volunteer activities to improve and conserve the regional, global, and national environment (such as air quality, water quality, ocean temperature, ozone depletion, global climate change) instead of evaluating and tracking these indicators. Nonetheless, some companies measured a few indicators of ECIs, such as, ozone depletion and global climate change. They estimated and reported the total amount of ozone depletion material used and amount of materials that cause global climate change generated. Many companies reported their

No	Questions	Number reported	Percent
1	Local or regional air, water, land, flora, and fauna quality, e.g. concentration of a specific air contaminant; water contaminant groundwater or surface water; soil contaminant or nutrients, and etc	25	48
2	Use of stratospheric ozone depletion substances (ODS)	21	40
3	Release of greenhouse gases (CO2)	40	77
4	Release of photochemical smog causing chemical	1	2
5	Local or regional weather, temperature, average amount of rain, and snow	0	0

Table 12 - The Present of ECIs in Profit and Individual Companies.

volunteer activities in order to participate in improving and conserving items of ECIs, like local or regional air, water, land, flora, and fauna quality. Table 12 illustrates the present of ECIs in profit and individual companies.

Even though local or regional air, water, land, flora and fauna quality were reported as 48 % in this survey, the companies did not evaluate them as numerical data. These data were numbers from companies which reported their volunteer activities related to the ECIs in their environmental report. None of them reported indicator 5 (local or regional weather, temperature and average amount of rain and snow). However, some of them evaluated and reported amount of ozone depletion substance used or generated and amount of greenhouse gas released. This indicator is the highest of all indicators used, mainly because amount of CO_2 has been managed and required by international organization and protocol. The trend of ECIs in each main industry is presented in Figure 19.

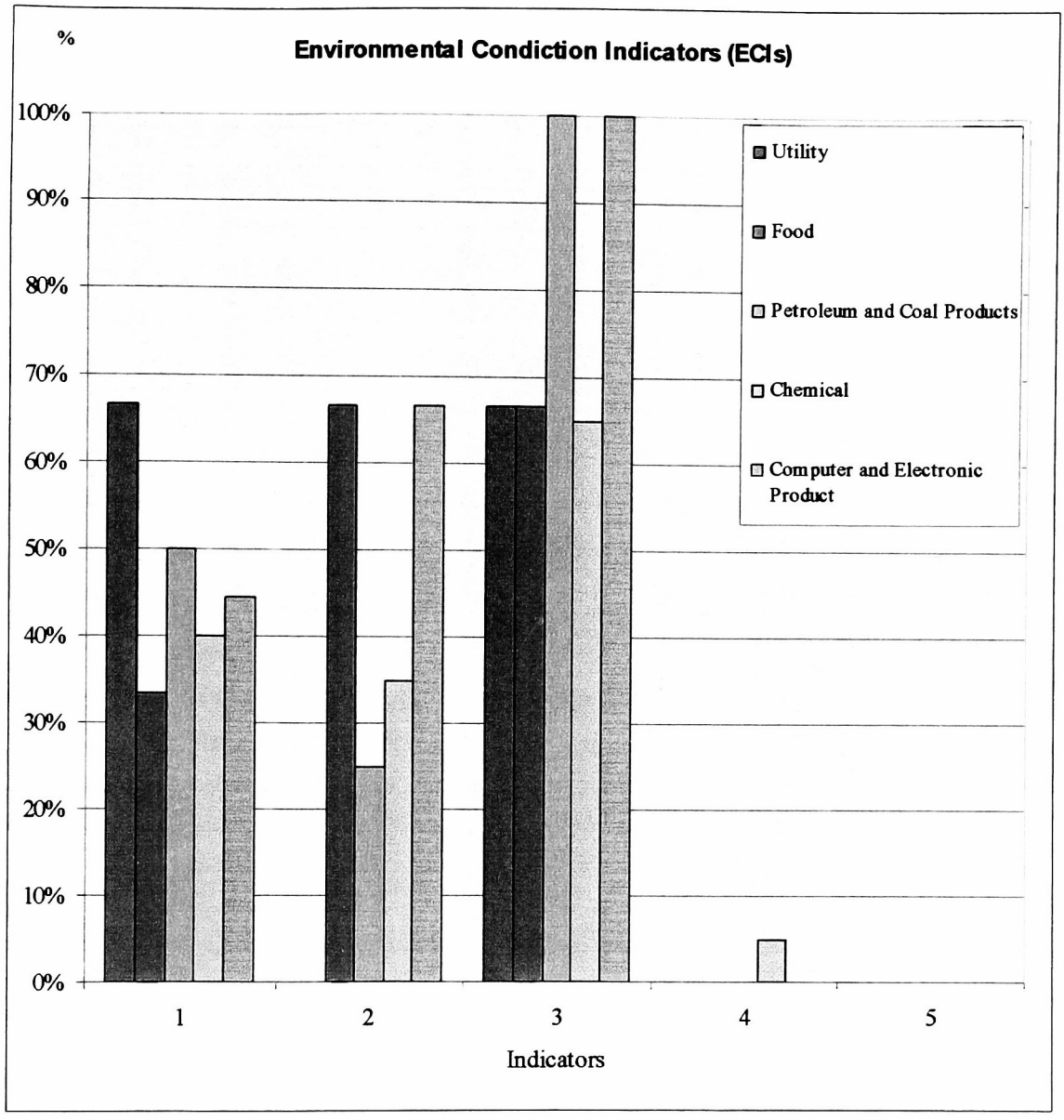

Figure 19 - The distribution of ECIs in Each Main Industry

6.0 Discussion

The objective of the previous survey was to identify environmental performance indicators that were reported and used in environmental reports of large and global companies. The survey also served to delineate the distribution of environmental performance indicators in accordance with the different types of industries, and to evaluate and demonstrate the need of environmental performance evaluation in several types of industries of SMEs. Furthermore it assisted in identifying what kind of EPIs will be most useful for SMEs through recent trends and types of large and global companies' EPIs. Lastly it can be used to recommend proper elements to be disclosed in EPE reports of SMEs. In order to complete these objectives, this step will discuss the comparison of the results of the survey and other programs related to environmental performance evaluation, such as, Sustainability Reporting Guidelines of the Global Reporting Initiatives (GRI), Environmental Self-Assessment Program of the Global Environmental Management Initiatives (GEMI), and the INEM (International Network Environmental management) Sustainability Reporting Guide.

6. 1 The Global Reporting Initiative (GRI)

The GRI was established by the Coalition for Environmentally Responsible Economics (CERES) in partnership with the United Nations Environment Program (UNEP) in 1997. The GRI is a long-term, multi-stakeholder, international undertaking whose mission is to develop and disseminate globally applicable sustainability reporting guidelines for voluntary use by organizations reporting on the economic, environmental, and social dimension of their activities, product and services. (Sustainability Reporting Guidelines on Economic, Environmental, and social Performance, June 2000).

Large and global companies had evaluated and reported just the results of their environmental performance in their environmental reports rather than results of economic and social performance until Global Reporting Initiative (GRI) announced the public release of the exposure draft of the Sustainability Reporting Guidelines in 1999. At that time, many companies reported lagging indicators of end-of pipe control instead of proactive leading indicators; even though, they voluntarily revealed environmental

reports. Many companies began to recognize the need and importance of the environmental performance reports when thirty-one pioneering companies participated in a pilot program for testing public reporting guidelines in 1999. They might consider integrating the results of environmental performance evaluation into business performance and decision-making process.

The GRI Guidelines (the "Guidelines") are a basic format for reporting an organization's economic, social, and environmental performance. The guidelines:

- Support organizations to disclose reasonable and appropriate evaluations of their economic, environmental, and social performance;
- Explain reporting principles and particular content to provide the preparation of organization-level sustainability report;
- Provide benchmarking and evaluation of sustainability performance with respect to performance standards, and voluntary initiatives; and
- Encourage comparability of sustainability reports.

According to the GRI Sustainability Reporting Guidelines published in 2002, the Guidelines consist of five parts: Introduction part; Part A: Using the GRI guidelines; Part B, Reporting Principle; Part C, Reporting Content; and Part D, Glossary and Annexes. Part C, which specifies the content of a GRI report, consists of five sections:

- Vision and Strategy: explanation of the reporting organization's strategy associated to sustainability, including a commitment of the CEO;
- Profile: overview of the reporting organization's structure and operations and of the scope of the report;
- Governance Structure and Management System: explanation of organizational structure, policies, and management system, including stakeholder engagement efforts;
- GRI Content Index: a table provided by the reporting organization identifying whether the information listed in Part C of the Guidelines is included in an organization's report or not; and
- Performance Indicators: measures of the impact or effect of the reporting organization separated into incorporated, economic, environmental, and social performance indicators.

There are three elements (economic, environmental, and social performance indicators in the main elements) reported by the Sustainability Reporting Guidelines.

6.1.1 Economic Performance Indicators

Economic performance in these guidelines relates to an organization's impacts on the economic conditions of its stakeholders and on the economic systems at the regional, national and global levels. Economic impacts are separated into two parts, direct and indirect impacts.

The economic performance indicators on direct impacts are used to track the monetary flows between the organization and its main shareholders and stakeholders; designate how the organization affects the economic circumstances of those interested parties, such as, shareholders and stakeholders. Indirect impacts stem from externalities that generate impacts on the communities. Externalities are those costs and benefits that that are not reflected in the monetary amount of the transaction. Examples of economic performance indicators are presented in Table 13

6.1.2 Environmental Performance Indicators

Environmental performance indicators of sustainability focus an organization's impacts on living and non-living natural systems, including land, air, water, and ecosystem. Environmental performance indicators can measure both absolute values and normalized values, such as, raw materials per unit of product. Absolute values inform a sense of scale or magnitude of the impact, while normalized values present the organization's efficiency and provide comparison among similar organizations, companies in the same industrial group. Normalized values, rather than absolute values, can help diverse interested parties to understand and evaluate an organization's environmental performance. Environmental performance indicators in the guideline are divided into ten aspects: material; energy; water; biodiversity; emission, effluents, and waste; suppliers; products and service; compliance; transport; and overall. Table 13 illustrates examples of environmental performance indicators.

6.1.3 Social Performance Indicators

Social performance indicators of sustainability can be measured by an analysis of the organization's impacts on stakeholders at the local, national, and global levels. These indicators may influence the organization's intangible assets, such as reputation and image. Social performance evaluation may be more difficult than environmental performance evaluation. The Guidelines have been divided into four categories: labor practices and decent work; human rights; society; and product responsibility. Some examples of each category described in GRI guideline are presented in Table 13.

Although organizations using the Guidelines were numbered at two hundred and four companies in April 2003, not all of them may measure, evaluate, and report their environmental performance indicators according to the standards of the Guidelines. The GRI also mentions that the decision to evaluate and report their performance according to the Guidelines is an optional activity, and not a requirement. The GRI encourages an organization to evaluate and report its diverse performance or environmental reports with flexibility in using the guidelines. Many companies using the Guidelines use "Sustainability Report" as a title of their performance reports. However, some of them have not used this name and have not followed the entire instructions described in the guidelines. They have evaluated and reported other figuration of economic, environmental, and social performance indicators in accordance with their activities, products, and services related to such indicators.

Sample companies selected for this research consisted of forty companies of GEMI members and twelve companies using the GRI guideline. Of the forty companies of GEMI members, twelve (3M, Anheuser, Aventis, Bristol-Myers Squibb, Dow Chemical, Hewlett Packard, Intel, Johnson & Johnson, Motorola, Novarits, Philips, and Procter & Gamble) are also using the GRI guideline. Twenty-four of the fifty-two sampled companies (46 %) are using the GRI guidelines. The number of companies using the guidelines should increase because the interest of diverse interested parties, such as the public and stakeholder, on the GRI Sustainability Report and the credibility of this GRI report are being raised. As presented in table 5 in chapter 5, the distribution of industries of the twenty-four companies indicate the chemical manufacturing industry groups

(42 %) and computer and electronic product manufacturing (25 %). Hence, it may be concluded that both industries use the GRI guidelines.

Performance	Examples of indicators
Economic performance	- net sales/profit, intangible assets - investment (human capital, R&D) - cost of all goods, materials, and services purchased - total payroll and benefits broken down by country increase/decrease in retained earnings at end of period -subsidies received broken down by country or region -donations to community and other groups.
Environmental performance	- materials use (tones) - percentage of materials used that are waste (tones) - direct/indirect energy use (Joule) - water (liters or cubic meters) - total amount of air emissions, effluents and waste (tones) (Greenhouse gas, ozone depletion substances, and etc) - significant spills of chemical, oils, and fuel - environmentally friendly products and services - land-use/biodiversity - incident of and fines for non-compliance with all regulation and other requirements
Social Performance	- average hours of training per year per employee - workforce retained in conjunction with other employers human rights health and safety - procedures/programs preventing all forms of discrimination in operation, including monitoring systems and results of monitoring

Table 13 Examples of Economic, Environmental, and Social Performance Indicators in the GRI Guidelines (GRI Sustainability Reporting Guidelines, 2002)

Even though many companies are interested in the GRI Report, they may evaluate and report different economic, environmental, and social performance indicators. Ultimately the method of evaluation and reporting is determined by their specific characteristics, such as activities, products, and services. Twenty-four companies also reported their environmental reports or similar reports with different titles; contents; economic, environmental, social indicators; and styles. Examples of titles of environmental reports from sample companies are presented in Appendix 2. Most of them did not follow the performance indicators of the guidelines, but a few companies (for example, International Paper), compared their economic, environmental, and social performance indicators with performance indicators of the guidelines, in order to raise the credibility of their sustainability reports and to verify them.

Most of the indicators used for this research were included in performance indicators described in the Guidelines. The main difference between indicators of the GRI guidelines and the indicators used in this research is the method for distributing indicators into categories.

The Guidelines identifies the economic, environmental, and social performance as valuable and measurement performance indicators of organizations. This may be due to the fact that GRI believe that completeness and comparability in economic, environmental, and social reporting were best served when all reporting organizations adhere to a common structure. Accordingly, the fundamental concept of performance indicators of the Guidelines is broad in scope and considers accomplishment related to the environmental management system as well as the entire results of an organization's various management systems, such as business, finance, company ethical, and social service. Therefore, an organization may have enough resources, such as human, materials, equipment, financial power, and time, to completely implement these Guidelines.

On the other hand, indicators for this research were categorized into Management Performance Indicators (MPIs), Operational Performance Indicators (OPIs), and Environmental Condition Indicators (ECIs) defined in ISO 14031. The base line of these categories was the environmental management system. MPIs and OPIs have been closely related to each other. In general, the results of operational performance result from the

management performance. For example, a new environmentally friendly product is an operational performance indicator. This new product can be developed through applying design for environment, which is one of the environmental management tools among management performance indicators. Therefore, the new product may produce less waste and energy, or higher energy efficiency than those of previous products.

The management performance can also be improved by operational performance. The higher benchmarking of operational performance is set up and implemented, the more effective and better management performance may be established to complete such benchmarking targets. If an organization implements any kind of environmental management system, the organization may easily evaluate and report MPIs and OPIs because the environmental management requires a few indicators of MPIs and OPIs presented in Table 1 and 2.

6.1.4 Applying the GRI Guidelines in Small and Medium size Enterprises (SMEs)

SMEs related to chemical manufacturing and computer and electronic product manufacturing should seriously consider using the GRI guidelines to respond to their potential demands. Yet, they do not have to follow the guideline.

SMEs may not acknowledge the needs of voluntary environmental management systems like EMS and EPE as well as the GRI Guidelines because they think such systems may not have economic benefits. In addition, SMEs may have difficulty in applying these GRI guidelines because of the following reasons:

- Lack of resources, such as time, human power, and organizational capability, to monitor and analyze the performance of diverse indicators described in the Guidelines;
- Complicated and vague indicators, such as indirect economic indicators; location and size of land owned, leased, or managed in biodiversity-rich habitats; and indicators related to social performance indicators;
- Lack of accountability and transparency of these guidelines because they are continuously changed and revised; and
- Sophisticated reporting system and duplicity of existing reports; for instance, finance reports, annual reports, and environmental reports.

There is evidence that SMEs have insufficient resources, misunderstanding, and lack of the needs of voluntary environmental management systems like EMS and EPE. The GRI said that they will try to develop tools to help support SMEs to fulfill using the guidelines. They also believed that such tools will encourage SMEs to gradually improve to a more comprehensive reporting for sustainable development (The GRI Sustainability reporting guidelines, 2002).

However, if SMEs want to use indicators in the Guidelines for their environmental performance indicators, they can also apply and use them according to their characteristics. Environmental performance indicators described in the Guidelines may be used to evaluate and report SMEs' environmental performance because some of them have already been monitored in SMEs as records to comply with several environmental regulations or laws.

They can classify such records into indicators and aspects in terms of the Guidelines as much as they can do. If SMEs implement the environmental management systems like the ISO 14001 and EMAS, they may easily evaluate and report their performance because the ISO 14001 and EMAS require that an organization monitor the results of their environmental activities. Such records are related to internal auditing, employee education, operational control, emergency preparedness, and environmental objectives and targets. They may, also, clearly identify subjects, which they should evaluate and track through complying with requirements like 4.3.1 Environmental Aspect and 4.3.3 Environmental Objectives and Targets in ISO 14001. Accordingly, SMEs implementing environmental management systems, ISO 14001, EMAS, and others, may be able to use the Guidelines if they consider and implement the integration results of environmental management activities with several performance indicators of the Guidelines.

SMEs should create or select report profiles according to their activities and objectives of EPE. They do not have to follow the guidelines of the GRI, even though the large companies use the GRI guidelines. They can use general information related to environmental activities and EPE, such as company information, environmental organization, results of EPE, and environmentally friendly activities, products, and services; much as the large companies reported in their environmental reports. However,

SMEs should consider and apply different report elements in association with objectives and audiences of EPE.

6.2 GEMI (Global Environmental Management Initiative)

In 1994, Global Environmental Management Initiative, one of the international environmental institutions which research and study diverse environmental management tools, as well as, health and safety excellence, published Environmental Self-Assessment Program (ESAP) based on the International Chamber Commerce's (ICC) business charter for sustainable development. This program has a rating system in order to evaluate and score the level of an organization's environmental management system, including operational performance. However, this program might not separate environmental performance into distinct indicators, such as MPIs, OPI, and ECIs described in ISO 14031 because ISO 14031 might be published later than the ESAP is released.

The ICC's twelve principles in the ESAP are the major aspects of environmental management and could be used as MPIs. Operational performance mentioned in ISO 14031 also is included in one of the management performance principles. To score the rating management performance, the ESAP determined detailed indicators according to twelve individual principles. The twelve principles/management performance indicators and relevant business activities are presented in Table 14

The main criteria for evaluating environmental performance in this ESAP are whether to identify environmental aspects and impacts; to have mechanism or documentation to carry out environmental activities; and to integrate environmental activities into other management like business managements of health and safety. Most of the operational performance indicators in this program were designed to evaluate in the principle "facilities and operation".

This ESAP focuses on the system for evaluating an organization's environmental management like management performance indicators (MPIs) surveyed in this thesis. Some indicators or principles, such as integrated management and employee education, were surveyed in this thesis. The strongest point of this program is that an organization can evaluate the level of environmental management system with numerical values. In general, scoring several performance indicators will be the best method to evaluate an

organization's activities. The scoring system to assess an organization's performance has several benefits such as:

Business Activity	Principles/indicators
Policy Setting	Corporate Priority Prior Assessment Products and Services Precautionary approach
System and Procedures	Integrated Management Facilities and Operations Research Emergency Preparedness
Implementation and Education	Employee Education Customer Advice Contractors and Suppliers Transfer of Technology Contributing to the Common effort
Monitoring and Reporting	Process of improvement Openness to concerns Compliance and Reporting

Table 14 - Twelve Principles (environmental management performance indicators) in the Environmental Self-Assessment Program. (GEMI, November 1994.)

- Scoring company's performance for each element determinates area of weakness and strong point;
- Element performance degree descriptions support an instruction for an organization to achieve higher accomplishments;
- Allotting an importance weighting to individual element can compare element importance with company performance;

- Annual achievement of the ESAP explains changes in organization performance over time; and
- The results of scoring can be used to set up specific and numerical objectives and targets like bench-marking.

If an organization is able to score and report the environmental management performance indicators (MPIs), it would be better for interested parties, as well as, the organization, as it can show the quantitative results of MPIs. However, such scoring system has several flaws. This program requires the organization to decide on the extent of weighting in order to estimate a score for the entire principle. An organization has to weigh the importance of each element in the principles, and the extent of this weighing may differ dependent on its characteristics and judgment based on its environmental aspects and impacts. Accordingly, the results of this evaluation can be evaluated differently and reported dependent on what they decide is the importance of each element. In spite of the fact that two companies in the same industry group implement this program to evaluate same activity with analogue procedures or documentation, the results can be different due to different activity weighing.

Through Table 5 in chapter 5 the main types of industries of the forty members of GEMI are Utilities (8 %), Petroleum and Coal Products Manufacturing (8 %), Chemical Manufacturing (40 %), Computer and Electronic Product Manufacturing (15 %). This distribution is similar to the total sample companies in Figure 2 The distribution of Industrial Code. Now that Chemical Manufacturing (40 %) and Computer and Electronic Product Manufacturing (15 %) have significant environmental characteristics such as use of natural resources and energy; and recycling and reusing of products, many companies related to those industry groups might voluntarily participate in several environmental institutions. Many companies, in both industries, implement environmental management tools such as ISO 14001, EPE, Life Cycle Assessment, Design for Environment, and Responsible Care compared to companies in other industries. Most of the companies in these industries are large and global companies.

Forty companies of GEMI were examined to identify a range of environmental management indicators (EMIs), such as MPIs, OPIs, and ECIs, reported their environmental performance. Even though they were members of GEMI, they did not

report the scores of environmental management in terms of the principles of this ESAP. They only used parts of the principles to evaluate and report their performance indicators. They described what they had completed in terms of these principles in their environmental reports. Most of them expressed that they were integrating environmental management systems into their business management and strategy in all functions and levels of the organization. They might keep and apply the results as internal communication information to improve internal environmental management, but not disclosed as external data. The result of scoring the environmental management performance can be facilitated as a tool of benchmarking for continuous development of environmental management performance indicators (MPIs).

6.2.1 Applying the ESAP in Small and Medium size Enterprises (SMEs)

SMEs relevant to Petroleum and Coal Products Manufacturing industry, Chemical Manufacturing, and Computer and Electronic Product Manufacturing should consider applying the ESAP and the guidelines of GEMI because large and global companies in both industries have participated in voluntary programs of GEMI and may promote them to establish EMS or implement this ESAP gradually. Most companies in the Utilities industry might be large companies, due to their industry characteristic; then, it may not be necessary for SMEs in this industry to consider applying the ESAP and guidelines of GEMI.

SMEs without environmental management systems may have difficulty in applying this program, because the ESAP was developed as a tool to improve environmental management systems. On the other hand, SMEs with EMSs can easily use this program so that they can estimate the level and position of EMSs, and measure and improve environmental management performance over time, since they have already implemented some indicators or principles in order to maintain and establish their EMSs. It is also not easy for SMEs to understand and evaluate each indicator of such principles, because the resources, such as human power, written documentation, and appropriate responsibility for implementing basic activities for this program, might be insufficient. However, if SMEs want to carry out sustainable development on the environmental and business aspects, they may be able to apply twelve principles as MPIs and OPIs. This is because

the principles and indicators are necessary to establish, evaluate, and improve their environmental management system, sustainable development, and business benefits and strategies. Accordingly, they should select and change appropriate indicators from those principles and indicators according to their environmental activities, products, and services; the trend of competitive companies and the same industry groups; and the needs of interested parties. The indicators relevant to several environmental regulations and other requirements, and superficial costs, such as expenditure for dealing with waste disposal and benefits from recycling and reductions, should be selected to evaluate SMEs' environmental performance.

In 1995, GEMI performed a survey to identify indicators to measure environmental performance. Forty-one companies participated in that survey. Although it is not clear whether this survey used ESAP, we can use these results because these indicators are included in the indicators of the ESAP as well as the survey for this thesis. The comparison of the result of the fore mentioned survey with this thesis is presented in Table 15.

From Table 15, we can see that some indicators, such as number of notice of violation and permitted air emissions increased. In other words, the need of these indicators is gradually increasing. Accordingly, SMEs may need to consider such indicators when they set up indicators needed to measure their performance.

6.3 INEM (International Network for Environmental Management)

The International Network for Environmental Management (INEM), established in 1991 by three existing business associations for environmental management in Germany (BAUM), Austria, and Sweden, is the world federation of nonprofit national business associations for environmental management. They consist of about thirty business associations and Cleaner Production Centers in twenty-five countries. The INEM Sustainability Reporting Guide was published by Institute für Ökologische Wirtschaftsforschung (IÖW) and the Institute für MarkUmwelt-Gesellschaft(imug) in 2001. The INEM Sustainability Reporting Guide may be helpful to large corporations, as well as, small and medium sized enterprises, because this guide was created by practical experiences, such as preparation of sustainability reports, by leading companies in

Indicators	% of companies using measure(Number)	
	GEMI*	This survey
Number of recordable injuries/illnesses	80 (33)	77 (40)
Amount of hazardous waste generated	76 (31)	81 (42)
Quantity of toxic chemical released	61 (15)	69 (36)
Number of notice of violation	**56 (23)**	**85 (44)**
Type/volume of non-regulated materials recycled	**54 (22)**	**85 (44)**
Type/volume of non-regulated materials disposed	51 (21)	54 (28)
Permitted air emissions	**44 (18)**	**90 (47)**
Amount/type of fuel used	**44 (18)**	**88 (46)**
Amount of water used	**39 (16)**	**75 (39)**
Total annual EHS operation costs	36 (15)	56 (29)
Ozone depleting substance use	32 (13)	40 (21)

* National Association for Environmental Management, "Performance Measurement of EHS Management Programs Survey," November 16, 1995

Table 15 The Comparison the Result of This Survey with This Thesis.

Germany, such as the Gundlach group and Otto Versand GmbH &Co. The sustainability reporting guide, like the GRI Guidelines, consists of three dimensions of sustainability, Social Performance, Environmental Performance, and Economic Performance. However, indicators for these performances would be determined according to the organization's goals, synergies, and contradictions observed in the process, and they may not be fixed indicators like those of the GRI.

6.3.1 Social Performance

Social Performance is concerned with the attention of employee interests and global equity, activities related to the poverty and compliance with social minimum standards. The key indicators recommended in this guide are presented in table 16.

A few indicators will be selected in accordance with the organization's activities, policies or strategies, and objectives. Only a few companies participated in this survey like the Procter & Gamble Company disclosed the number of trainees by sex; the rate of fluctuation; the proportion of severely disabled employees in relation to the total; and the proportion of women among middle and top level executives. However, most of them might not report social indicators distributed by sex, but common social indicators, such as, the number of employees, the number of accidents, and the number of days lost could be found in their environmental performance reports.

6.3.2 Environmental Performance

According to this guide, environmental performance may be determined depending on the degree of an organization's significant environmental aspects and impacts, environmental activities, products and services. Today, the trend of the indicators for reporting sustainable development in large companies goes beyond the common environmental indicators, such as waste, energy, air emission, waste, and hazardous substances. Most companies would like to report and evaluate economic benefits, eco-efficiency, and effectiveness of their successful performance and interests in the global environmental issues, for instance, CO_2 emission for global warming and ozone depletion substances. Such activities and reports can give interested parties environmentally sound and sustainable development images. As a result of these activities, the companies may attain credibility and transparency from their investors, stake-holders, and customers, and their environmental benefits may contribute towards increasing their sales. Table 16 illustrates examples of environmental performance indicators described in the INEM guide. Most of the environmental indicators mentioned in table 16 are included in the survey for this thesis. Most companies examined in this work may be able to directly follow the INEM sustainability reporting guide with existing environmental performance indicators. Accordingly, these environmental performance indicators may be used in large companies as well as small and medium-sized enterprises.

6.3.3 Economic Performance

Many interested parties, such as companies, stock market, global market, customers

Performance	Examples of Indicators
Social Performance	• the number of employees and part-time employees by sex; • the number of trainees by sex; the rate of fluctuation; • the proportion of women among middle and top level executives; • the percentage of minorities among middle and upper level executives; • the number of days of further training per employee by sex; • the number of accidents that must be reported; • the number of days lost and the rated of absenteeism.
Environmental performance	• the consumption of all materials with a focus on regenerative, recycled, and especially hazardous; • the total consumption of energy differentiated by type of fuel and source; • the volume of the water consumption; • emissions of greenhouse gases (Kyoto Protocol); • emissions of gases that damage the ozone layer; • the total volume of waste to be disposed.
Economic Performance	• turnover; • the distribution of turnover among advance investments, wage and additional wage costs, the taxes, fees, and the results of normal business activity; • the use of profits (charity/different types of dividends/withdrawal/reserves); • for joint-stock companies; • the ratio of company capital and debts.

Table 16 - Examples of Performance Indicators described in the INEM Guide

and stake-holders, have recognized the importance of economic value of environmental activities and results. They are trying to evaluate and interpret the economic value of

environmental activities. Many environmental institutes like the GRI, GEMI, and INEM are studying and publishing the information and present companies' situations related to the economical value of environmental management. The important aspect of such a study is that it encourages many companies to promote economic value focused not only on business activities, but also environmental activities. As a result, many performance guides mention and describe guidelines and methods to evaluate and report economic performance as well as environmental performance in environmental performance reports. The INEM Sustainability reporting guide also explains economic performance. The examples of economic performance indicators they recommended are represented in Table 16. It is very difficult to determine the economic benefits of the environmental activities that are evaluated and reported in the environmental performance reports, because the conception of environmental accounting or finance are not yet fully established or acknowledged by the public or the companies. Economic indicators selected for this thesis were just a few indicators, such as sale, investment, and environmental costs. However, many companies, especially companies using the GRI guidelines, evaluated and reported economic performance according to the Guidelines in their environmental reports or analogue reports like Sustainability reports. Many companies began to consider several methods and metrics to evaluate and report the economic value in their performance reports. Even though SMEs do not typically report and evaluate environmental performance, they must have economic performance in their business. Therefore, SMEs may also be able to report economic benefits and costs on the environmental activities.

6.3.4 Applying the INEM guide in SMEs

SMEs may be able to more easily apply economic and social performance indicators in terms of this INEM guide than those of the GRI Guidelines. Because most of performance indicators described in the INEM are related to compliance with social minimum standards and finance standards, SMEs do not have to complicatedly or systematically analyze and interpret the results of their business and environmental activities. They may be able to report and evaluate their sustainability through tracking and collecting the accomplishments of general activities.

If SMEs implement the environmental management system, they have to track and establish several goals related to environmentally friendly activities, such as reduction, recycle, reuse, and clean production, so that they can maintain and carry out the environmental management system in place. Therefore, they can evaluate and analyze the results of their environmental management system, which can be used as environmental performance indicators of the INEM guide. On the other hand, SMEs may be able to adopt the performance indicators mentioned in the INEM guide even though SMEs do not have environmental management systems. This is due to the comparatively flexible requirements of the INEM guide. Accordingly, SMEs may be able to select and evaluate appropriate performance indicators in table 16 as benchmarking indicators for sustainable development.

6.4 Appropriate Application of Environmental Performance Evaluation in SMEs

6.4.1 The Need for Environmental Management System

SMEs may have two types of barriers, internal barriers and external barriers, to implement environmental management systems (EMSs), including environmental performance evaluation (EPE)

First, internal barriers to EMSs are the following:

- the lack of human resources rather than financial ones;
- the lack of acknowledgement needed to substantially implement EMSs, including decision on environmental aspects and significant environmental impacts and fulfilling internal audit and evaluation independently
- misunderstanding of what EMSs are, how they establish and what benefits can be achieved from their implementation; and
- the lack of acknowledgement of top management on the needs of EMSs.

Second, external barriers are;

- insufficient drivers for EMSs adoption and uncertainty about the market benefits of such systems;
- low environmental aspects and impacts or no environmental issues;
- skeptical thinking about the benefits, costs, savings and customer rewards related to environmentally sound action, and a belief that benefits accrue slowly but costs

quickly;

- thinking that the environment is not a crucial business issue; and
- indifference of interested parties, like customers and stakeholders, on SMEs' environmental performance, which is a key reason why SMEs consider environmentally friendly activities. (Ruth Hillary, 1999)

Once these problems, especially internal barriers, are partially solved or diminished, SMEs may be able to determine, evaluate, and report their environmental performance indictors. In addition, if they want to apply to one of the several environmental performance guidelines like the GRI, GEMI, and INEM, they should have environmental management systems or systematical tracking systems because EMSs require diverse environmental activities, such as setting up environmental goals, monitoring compliance with environmental regulations, and assigning responsibilities needed to evaluate environmental performance. Therefore, if a small and medium organization implements an environmental management system, the organization may effectively and efficiently evaluate and report their performance. On the other hand, the small and medium organization may have difficulty in identifying and monitoring the fundamental data to evaluate environmental performance indicators.

There are several benefits from adopting an EMS like ISO 14001 in SMEs

- acquiring a large number of organizational improvements and efficiencies;
- improving communication tools, skills, knowledge and behaviors;
- attracting new business and customers, and meeting the demand of diverse interested parties;
- accomplishing positive outcomes in terms of improved environmental performance, compliance with regulation and efficient operation and use of energy and material, such as recycling and reuse;
- identifying several significant aspects and impact needed to evaluate their performance;
- monitoring the results of several environmental activities, products, and services; and
- increasing company's image and good relationships with stakeholders. (Ruth Hillary, 1999)

6.4.2 Selecting Management Performance Indicators (MPIs)

SMEs may be able to select or determine the management performance indicators (MPIs) through these strong points. For example, MPIs were used over 70 % of the companies in this study. Whether a company uses several environmental management tools and whether companies participate in volunteer activities, results can be easily measured if an organization operates the environmental management system.

SMEs do not have to follow social and economical performance indicators addressed in GRI, GEMI, and INEM. Instead, they should independently select and evaluate some of the indicators in accordance with their size, capabilities, and activities, so that they can evaluate and report management performance indicators in terms of ISO 14031.

6.4.3 Selecting Operational Performance Indicators (OPIs)

If SMEs try to evaluate and report their environmental performance with sustainability described in the GRI, GEMI, and INEM, they may progress with the following five steps to develop performance indicators for sustainability.

- 1st step: identify and monitor facility compliance and conformance indicators;
- 2nd step: identify and track facility materials use and performance indicators;
- 3rd step: develop and monitor facility effect indicators;
- 4th step: develop and monitor supply chain and product life cycle indicators; and
- Last step: define and continuously measure sustainable system indicator. (Rene Van Berkel, 2001)

These steps may be applied differently according to their products, activities, and services. An organization should also communicate and use data collected from environmental performance indicators. Figure 20 illustrates the flow from data to determine indicators. In SMEs, they can apply two types of operation indicators, lagging indicators, such as the amount of waste and the total used amount of water, and leading indicators, for example, eco-efficiency and sustainability. "Normalization is an important technique for tracking environmental performance. Tying emissions, and resources Consumption to a unit of product helps clarify whether positive environmental trends are the results of pollution prevention activities or simply the effect of decreased

manufacturing (for example from plant closing or a shift to contract manufacturing)" (GEMI, Measuring Environmental Performance, 1998)

If SMEs want to apply lagging indicators, they do not have to consider normalization and standardization because the data first identified for lagging indicators may be used to directly evaluate their performance without modifying them. "Lagging indicators are the type of metrics most commonly reported and the results of environmental practices or operations currently in place. Leading indicators measure the implementation of practices of measures which are expected to lead to improved environmental performance" (GEMI,

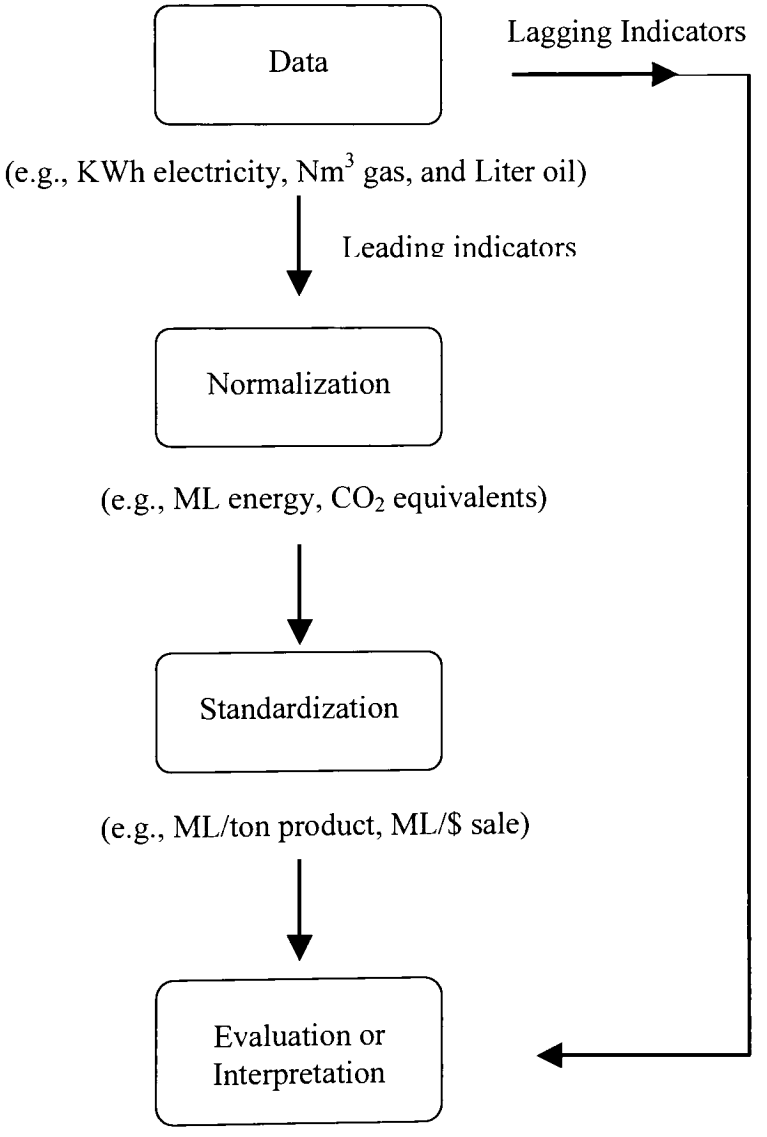

Figure 20 - The Flow to Evaluate Data to determine Indicators

Measuring Environmental Performance, 1998). They can just evaluate the output data over time or comparison to their objective and target, which are already planned. On the other hand, if SMEs want to use leading indicators, they should perform normalization and standardization. They may be able to achieve the most flexible and stable data structure needed to evaluate environmental performance indicators by normalization and standardization. SMEs should also consider lagging and leading indicators, because these two types of indicators are widely evaluated and reported by the global and large companies.

As mentioned before, the environmental management system will help SMEs to carry out these activities. In cases that SMEs are without EMSs, they may need to change or consider the following:

- Organizational culture: environmentally friendly activities, such as reducing waste, are related to changing behavior and creating a culture of productivity and environmental activities among employees and management at all levels and positions of the organization. For example, SMEs with certification of ISO 14001 have to implement these activities according to its requirements such as environmental responsibility and operation control;
- Problem Awareness: Identifying opportunities to take action and determine their performance indicators;
- Communication of Information: effective communication and dissemination of relevant information internally are necessary to develop, follow, and integrate into daily operations of the organization; and
- Simple actions: the initial adoption of performance evaluation does not require major investments and activities, which may be costly. The purpose of performance evaluation is to carry out sustainable development through a more rational use of resources and optimizing production process and product design. (Sustainable Business Associates, 1998)

SMEs should understand the main elements of performance indicators, and put in place the management procedures to incorporate these practices into the day-to-day operations of business. They should also try to take a more systematic approach to improve the eco-efficiency and competitiveness of their companies.

6.4.3.1 Eco-efficiency for Operational Performance Indicators

In 1992, the World Business Council for Sustainable Development (WBCSD) published its conception of eco-efficiency. The council is an association of one hundred and thirty international companies united by a shared commitment to sustainable development. WBCSD defines eco-efficiency as follow, "Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs, and resource intensity throughput the life-cycle to a level at least in line with the earth's estimated carrying capacity" (measuring eco-efficiency a guide to reporting company performance, WBCSD). Eco-efficiency is a key concept, which can help support companies, individual, and other organizations promote more sustainable development. It considers two essential ingredients, economic and environmental progress, which are necessary for economic prosperity to increase efficient use of resources and lower emission. The framework of eco-efficiency is flexible enough to be used widely and easily understood against the business areas and an organization's characteristics. Therefore, SMEs can use eco-efficiency indicators as a means of making and measuring progress toward economic and environmental sustainability. Eco-efficiency can be a measure of the business value of environmental program as well as the environmental performance of business areas.

Indicators needed to evaluate eco-efficiency are divided into two types of indicators, generally applicable indicators and business specific indicators. Generally applicable indicators can be used by all businesses, and business specific indicators can be more likely to be individually defined in accordance with each company or business sector. Eco-efficiency is presented by:

$$\frac{\text{Product or service value}}{\text{Environmental influence}}$$

(Hendrik A. Verfaillie and Robin Bidwell, 2000)

The generally applicable indicators for product or service value in a numerator are: quantity of products, services produced, or sold to customers; net sales; net profit, earning, and income. It can be measured in mass, volume, or number and is the most easily measurable and available indicators for all businesses, even SMEs. The generally applicable indicators for environment influence in a denominator are: energy

consumption; water consumption; material consumption; greenhouses gas (GHG) emissions; ozone depletion substance (ODS) emissions; acidification emissions to air; and total waste.

Business specific indicators in product or service value are Earning Before Interest and Tax (EBIT), which is profit before interest expense and income tax; gross margin; and value added. Business specific indicators for environmental influence are priority heavy metal emissions to surface water; waste to landfill; waste to incineration; photochemical oxidant creation, such as VOC and NOx; chemical oxygen demand (COD) to surface water; packaging; and GHG emissions from purchased electricity, in metric tons of CO_2. However, some business specific indicators, such as waste to landfill and waste to incineration, can be used as generally applicable indicators because these are common environmental impacts, generated from general activities of a company.

We can see that indicators used over 60 % among indicators selected for this thesis are included in eco-efficiency indicators as well as indicators of INEM and GRI. It may mean that such indicators used over 60 % may be the most useful indicators needed to evaluate and report environmental performance. It does not matter what types of industries they are, because OPIs are generated from the results of common environmental activities in several types of industries. As a result, SMEs should consider these indicators as operational performance indicators if they want to separate performance indicators with regards to ISO 14031 terminologies.

6.4.4 Type of Industries in SMEs

Among 16 industry groups participated in this survey, the six industry groups, Utilities, Food Manufacturing, Beverage and Tobacco Product Manufacturing, Petroleum and Coal Products Manufacturing, Chemical Manufacturing, Computer and Electronic Product Manufacturing industries are actively assessing and reporting their environmental performance related to their activities, product, and service. Since such industries are very closely related to their industry characteristics and environmental impacts, they may be very interested in environmentally sound activities and environmental management tools, such as EMS, EPE, Life Cycle Assessment (LCA), and Design for Environment (DfE). Currently, large and global companies require their branch companies around the

world to establish and implement environmental management system, like ISO 14001, and report their environmental performance. For example, Kodak and Cannon reported the number of companies that acquired ISO 14001 certification. Volvo group required their contractors or subcontractors to acquire ISO 14001 within a specific period. In other words, the demands of large and global companies on environmentally sound activities of their contractors and subcontractors are gradually increasing. If a large and global company implements advanced environmental tools like LCA and DfE, the company wants its contractor to provide the company with environmental information about a product or service purchased from its contractors.

Many contractors and subcontractors related to large and global companies may be small and medium size enterprises. They should swiftly and actively respond to meet their customer's demands. The SMEs in the six industries above and their subcontractors and contractors should seriously consider not only establishing and implementing EMSs, like ISO 14001 and EPE, but also getting useful environmental information and performance.

7. Conclusion

The environmental performance evaluation is no longer implemented only in large and global companies. Consumers of SMEs are more responsive to environmental concerns when they buy, use, and recycle products. Many corporations are recognizing that reducing environmental impacts will benefit the community and their long-term profitability. Environmental protection and evaluation has become a big business.

Better management of corporate environmental performance in SMEs can improve international competitiveness. Yet these benefits can only be achieved if environmentally related expenditures are seen as corporate strategic investments and if environmental responsibility and corporate environmental strategy are integrated into the corporate culture. This integration requires a commitment from executives and employees at all levels in the organization, and especially in the functions of environmental, health, and safety; accounting/finance; and operations. Unless all three functions are committed to the corporate environmental strategy, corporate pronouncements by the chief executive are likely to remain only hollow mission statements.

It may not be easy to define the industry groups of SMEs that should implement environmental performance evaluation and establish environmental management systems for implementing EPE. Yet, from the survey and results presented in chapter 4 I saw that especially large global industry groups such as chemical manufacturing and computer and electronic product manufacturing have actively been evaluating and reporting their environmental performance evaluation, in terms of their characteristics and several guidelines. As a sequence, the SMEs' industries such as Utilities, Food Manufacturing, Beverage and Tobacco Product Manufacturing, Petroleum and Coal Products Manufacturing, Chemical Manufacturing, Computer and Electronic Product Manufacturing related to large and global industries should evaluate their environmental performance and establish environmental management system for EPE as well as sustainable development in the business area. If they implement EPE and EMS, they can acquire the economical and environmental benefits, and also proactively prepare the potential press and demands of interested parties regarding environmentally friendly activities.

This chapter will discuss the methods to implement environmental performance evaluation through environmental management system like ISO 14001 select and determine appropriate performance indicators and utilize and report environmental performance in SMEs.

7.1 Implementing EPE and the Relationship between EMS and EPE in SMEs

7.1.1 Implementing EPE in SMEs with Environmental Management Systems

The strong points of implementing EMS in SMEs were mentioned in chapter 6. The environmental management system may need to effectively and substantially evaluate and report environmental performance and follow various performance evaluation guides. SMEs implementing environmental management systems can systematically identify and perform the following things:

- value-creating opportunities to improve environmental performance;
- improvement of appropriate performance indicators, in terms of their characteristic;
- assignment of the responsibilities to evaluate and collect lagging data for performance indicators; and
- acquaintance with organizational culture, communication for information, problem awareness, and simple action for EPE.

There is also the fact that systematic environmental management methods are gradually broadening out into a sustainable development concept and demanding complex social, economic, and environmental performances of SMEs. In addition, environmental management systems can assist SMEs to evaluate such performances. SMEs may be able to use indicators related to environmental operating costs by the following activities:

- improving resource optimization rates and process efficiency;
- reducing waste; and
- using risk management to avoid fines and clean-up costs, reduce regulatory costs, and decrease insurance and overhead costs.

The results and metrics relevant to these activities can be selected and utilized as environmental performance indicators, such as MPIs and OPIs. Therefore, environmental management systems may help SMEs implement simple and suitable environmental performance evaluation.

SMEs implementing environmental management system, like ISO 14001, may implement environmental performance evaluation (EPE) by integrating their environmental performance evaluation into their environmental management systems.

7.1.2 Implementing EPE in SMEs without Environmental Management System.

SMEs have difficulty in applying environmental performance evaluation because they have not established environmental management systems and experienced the consequent alignment between environmental activities or indicators and business activities. Although an organization is a small or medium enterprise, the organization should not consider only the trend to implement environmental management systems by other companies from around the world, but also try to promote sustainable development by evaluating performance of their business aspects as well as environmental aspects. If SMEs without environmental management systems would like to implement performance evaluation, they should establish environmental management systems, like ISO 14001 or EMAS. To fulfill effective and substantial performance evaluation in SMEs, they should have systematical and functional cultures, such as an efficient organization and clearly assigned responsibilities. However, it is not always necessary for such environmental management systems to implement performance evaluation in SMEs. In addition, SMEs may not have enough skills and resources to establish and implement such environmental management systems. In such cases they consider the Plan-Do-Check-Act (PDCA) cycle format that forms the basic Total Quality Management (TQM), and the basic guideline described in ISO 14031. The basic activities in each cycle are presented in figure 21. If the PDCA cycle is incorporated into a management system for performance evaluation, this PDCA process can serve as an environmental management system.

7.1.2.1 Plan

SMEs, as well as large and global companies, must first look carefully into the planning of environmental performance evaluation. Careful planning will reduce many problems or barriers in the implementation, evaluation, and improvement stages. The following considerations should be considered when SMEs plan to implement environmental performance evaluation:

- the company's activities, organization and its unique environmental impacts

  each company has its own particular products, activities, services, financial

structure, legal and regulatory requirements, data collection and environmental impacts;

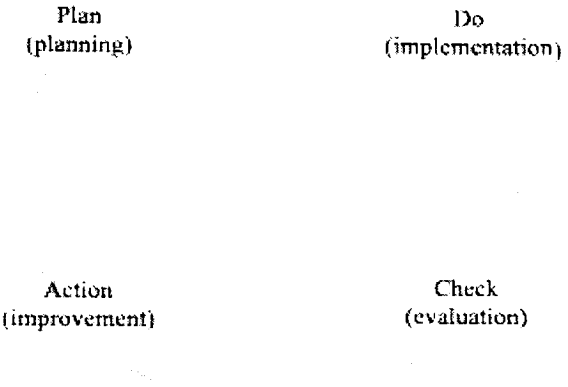

Figure 21 - The Plan-Do-Check-Act Cycle

- the audience for environmental performance evaluation – the indicators may be different according to interested parties, such as internal, government, public, investors, share-holders, and customers;
- objectives and targets – objectives and targets can support the criteria against which company performance is measured;
- indicators that drive performance – the methods and indicators selected should drive performance rather than just appraise. For example, a company trying to improve its compliance record with regulations should develop in-process indicators that identify and measure fundamental causes of non-compliance;
- consistency over time;
- use of data that are being collected for other business. Examples are hazardous wastes generated; release of toxic chemicals; air emissions and wastewater discharge; and work related accidents and illness;
- identification and definition of performance expectation and responsibilities;
- regular period to collect and report data; and

- normalizing data – allocations emissions, releases, and resource consumption to a unit of products. This can help clarify whether positive environmental trends are the results of pollution prevention activities on the effect of decreased manufacturing. "Normalize is the process of reducing a data structure to its simplest form and developing a data structure. Normalization is an attempt to achieve the most flexible and stable data structure possible, so future maintenance of the data structure can be reduced". (Durrell definition, (http://www.cu.edu/irm/stds/ddg/gloss.html)

After considering or identifying these elements above, SMEs should plan the detailed actions for implementing performance evaluation. Such detailed actions are:

- identifying the specific activities such as assigning responsibility, determining data format, and instructing employees related to environmental performance evaluation
- Selecting indicators like Management Performance Indicators (MPIs), Operational Performance Indicators (OPIs), and Environmental Condition Indicators (ECIs). Too many indicators in SMEs should be prevented.

7.1.2.2 Do

After planning the environmental performance evaluation, SMEs can collect, normalize, report, and communicate data needed to analyze and evaluate several management performance indicators. They can use simple checklists, which may be newly created or already in place.

Once the environmental performance data are collected and normalized, SMEs should consider the following elements:

- Is good environmental performance demanded and supported by upper management;
- Do the various organizational units support and do their part for good environmental performance; and
- Are the organizations' management systems appropriately matched to its environmental characteristics and flexible enough to accommodate change.

SMEs should try to simplify and diminish the collected data and normalize so that they can substantially drive internal environmental performance evaluation and be more meaningful to external interested parties.

7.1.2.3 Check

In this step, SMEs can evaluate and compare the collected data to determine if the selected indicators are useful and appropriate. Environmental performance evaluation should also determine whether the performance evaluation system drives continuous improvement. SMEs should consider the following:

- collecting the right data and reporting to responsible personnel in a timely manner, so that action may be taken quickly;
- being consistent with other reporting measures; and
- driving the right behaviors, such as reducing costs.

7.1.2.4 Act

The results of the evaluation may help answer the question of what to monitor or measure in order to identify the opportunities to promote sustainable and continuous development. A new indicator or opportunity that is determined after evaluating and reviewing performance indicators may affect existing standards and procedures, and need to be communicated. SMEs can, thus, improve their environmental performance system or indicators through redesigning their system. SMEs should repeat the process starting from the planning step of the PDCA cycle with the accumulated information from the action step. This PDCA process in SMEs will continuously implement and improve an environmental management system for environmental performance evaluation.

In this step, SMEs should consider the following:

- methods to report or communicate the entire results of environmental performance evaluation to appropriate interested parties in a timely manner;
- credibility of the performance reports;
- new objectives and targets of performance indicators; and
- getting interested parties' feedback. For example, employees, business units, public, and stakeholders.

7.2 Selecting Environmental Performance Indicators in SMEs.

To evaluate environmental performance, SMEs should determine several types of environmental performance indicator, such as MPIs, OPIs, and ECIs of the ISO 14031 standard; economic, environmental, social performance in terms of the GRI and INEM; and self-assessment, according to the ESAP of the GEMI. As mentioned

before, since SMEs do not have enough resources and capability to evaluate and analyze their performance, they should select and use comparatively simple types of indicator, such as MPIs and OPIs. After their performance improves, they may use more complicated and systematical indicators, like economical and social performance indicators. Among the three indicators (MPIs, OPIs, and ECIs), OPIs will be the most helpful to SMEs because they:

- are easily identifiable and measurable, because OPIs are based on regulations and other requirements;
- are easily associated with costs and benefits, such as reduction of waste and energy saving cost;
- are easily comparable over time;
- require the lowest effort to determine appropriate indicators; and
- are most the familiar to SMEs.

Therefore, SME should first focus on selecting and evaluating OPIs. It may be difficult for SMEs to develop and evaluate MPIs and ECIs. SMEs should not evaluate ECIs, especially, because they do not have the capability to develop and implement ECIs. This thesis will not make a conclusion about ECIs. SMEs should select and use appropriate OPIs and as appropriate MPIs from existing performance guidelines, such as the GEMI, the GRI, INEM, and ISO 14031, rather than try to develop them.

To select and use appropriate environmental performance indicators, SMEs should follow these six steps:

1. Identify interested parties and their concerns. The environmental performance indicators relevant to interested parties' work should be determined in conjunction with them. Table 17 illustrates the examples of interested parties and their point of view on the SMEs.

2. Find the most significant environmental aspects and impacts generated from the company's activities, products, and services. Since diverse environmental impacts, such as consumption and use of material and resource, pollution, and hazardous or solid waste, are generated from its activities, products, and services, the company must identify them in order to consider significant indicators in association with its characteristics.

3. Define a relevant unit. Most of environmental data are understandable if they relate to a unit of reference. Examples might include: 300 gal wastewater per unit of production, or 5 tons of solid waste per year per employee, and etc.

4. Assign responsibility for data collection and designate where it will be kept. To effectively evaluate and perform EPE, SMEs have to distribute environmental responsibilities into business areas, such as production, account, purchasing, management, human resource, and environmental department.

5. Select the performance indicators. That will allow environmental performance to be compared over time through linking with a unit of reference.

6. Communicate the company's performance to the appropriate stakeholders. SMEs should report the accomplishment of their performance indicators, so that various interested parties can compare and assess their performance and have an improved image of an environmentally friendly company. From this reporting, SMEs can generate economic or intangible benefits.

Interested parties		Examples of their main interests
Internal	Management representatives	-financial impact related to environmental liabilities, such as environmental costs and benefits, costs of compliance or non-compliance, and economic benefits -commercial advantages originated from environmental activities -effective and economical implementation of environmental management system -good environmental performance -compliance with regulation or customers' requirements related to environment
	Employees	-environmental impacts on the quality of life -environmental incidents and impacts -environmental performance and benefits -education and guidelines to avoid dangerous impacts -health and safety -risks to the environment resulting from the organization's activities

Table 17 Examples of Interested Parties and their Point of View on the SMEs.

Interested parties		Examples of their main interests
External	Investors and potential investors	-environmental benefits through environmentally sound activities -costs compliance or non-compliance, with environmental regulation -risks related to environmental activities, product, and services -sustainability
	Customers/ Contractor	-environmental impact derived from products and services -environmentally friendly products and processes -the unit or sale price derived from environmental activities
	Regulatory and legislative bodies, neighbors, communities, environmental groups, and public	-environmental loads including trends over time -environmental quality -global environmental issues, such as global warming and climate change -compliance with laws and regulations -consumption of resources

Table 17 Examples of Interested Parties and their Point of View on the SMEs.

SMEs can select and modify these indicators in Table 17, in terms of their characteristics, such as environmental activities, products, services, and significant environmental impacts. They can also obtain more detailed views from interested parties to determine appropriate indicators through the following: survey and questionnaires to customers and contractor; employee suggestions; market research; regulatory tracking and trending; voluntary guidelines; trends of the same industries; and participation in industry and public interested groups. The most important thing in selecting EPIs for SMEs is that they should determine and evaluate environmental performance indicators related to regulations and sustainable development.

7.2.1 Management Performance Indicators (MPIs)

Since Management Performance Indicators are leading indicators, which are in-process measures, MPIs may inspire the performance of the company's operations and assist evaluation of management efforts, decision-making and bench-marking to improve environmental performance as well as help integrate environmental performance with business strategy. Effective selection and implementation of MPIs can promote to positive changes in performance, identify core causes, and reveal challenges.

The easiest measurable and useful management performance indicators in SMEs may be indicators described in ISO 14001 Self-Assessment Checklist published by GEMI, INEM, and ISO certification bodies. It does not matter whether SMEs have implemented ISO 14001 and what kinds of industries SMEs are because this Self-Assessment Checklists deal with general environmental management activities according to ISO 14001 requirements. Examples of self-assessment can be accessed through the Internet at http://www.gemi.org.

SMEs should not use too many MPIs in the beginning, and should evaluate simple MPIs. They may have difficulty applying leading indicators in wide business areas, because it is not easy to quantity MPIs. All costs and revenues relevant to environmental performance should also be identified as MPIs (such as disposal costs, emission reduction, and saving costs), because this will provide opportunities to change and challenge activities according to financial expenditure and benefits. They can select and evaluate such MPIs in Table 1 of chapter 3, based on ISO 14031, indicators used over 60% in this survey, and appropriate MPIs of the GRI guidelines, GEMI and INEM described in previous chapter 6. The examples of possible MPIs in SMEs are:

- Number of voluntary environmental management tools used, such as Design for Environment, Life Cycle Assessment, Environmental Accounting, and environmental labeling;
- Number of achieved objectives and targets;
- Number of hours of environmental training per employee;
- Number of revisions of environmental policy;
- Number of years environmental management system was implemented, like ISO 14001;

- Number of internal or external audits and number of the corrective actions completed;
- Number of non-compliances with regulation and other requirements;
- Number of emergency training events and tests, and number of scenarios related to emergency situation;
- Number of recordable injuries and illness;
- Number of environmental, health, and safety reviews completed; and
- Number of communications to external interested parties.

7.2.2 Operational Performance Indicators

Small and medium sized enterprises should devote themselves move to selecting and tracking operation performance indicators (OPIs) than to setting up and measuring management performance indicators (MPIs). This is due to the benefits of OPIs mentioned previously in provision 7.2, such as simplicity, suitability, and familiarity to SMEs. They should primarily try to identify and fulfill simple, practical, common sense, and end-of-process measures of OPIs, known as lagging indicators that give evidence of increasing the company's productivity, while diminishing its environmental impacts. After they accustom themselves to implementing their EPE, they could try to evaluate advanced EPE tools, such as eco-efficiency to evaluate sustainability. The greater the importance of a company's environmental problems, the higher the priority for the company's OPIs

SMEs can use examples of table 2 - Operational Performance Indicators (OPIs) in chapter 3 Literature Review and the results of this survey described in chapter 5. Analysis and Results, to help select and use the general lagging indicators, which in general are measurements dealing with preventing the loss of materials, minimizing waste, conserving, and saving energy. These indicators are related to the first and second step; identify interested parties and their concerns and the most significant environmental aspects and impacts generated from the company's activities, products, and services among six steps to develop performance indicators for sustainability. The examples of operational performance indicators recommended for SMEs in this thesis are:

Input indicators:

- Amount of reduced the loss or use of raw materials;
- Amount of savings or use of natural resources, such as natural gas and water;

- Amount of savings or use of energy;
- Amount of savings or use of toxic substances; and
- Amount of savings or use of packaging;

Output:

- Amount of hazardous waste and solid waste generated;
- Amount of recycling, reuse, and reformulation of hazardous waste and solid waste;
- Amount of incineration, landfill, and treatment of hazardous waste and solid waste;
- Amount of emissions to air (exception for ozone depletion, photo smog, and global warming gas, such as CFC or CO_2 emission); and
- Amount of wastewater effluent.

Indicators for sustainable development:

- Cost of purchasing material, energy, natural resources, and toxic chemicals;
- Environmental costs for disposal, incineration, and landfill;
- Avoided costs from environmentally friendly activities, such as recycle, reuse, and reduction of water, waste, and energy;
- Amount of reduction or use of CFC, HCFC, CO_2, which are related to global warming, NOx and SOx for climate change, and ozone depletion substances; and
- Eco-efficiency.

In 1992, the World Business Council for Sustainable Development (WBCSD) recommended that companies integrate eco-efficiency information into their overall decision making and communications process. Internally, it should be part of a day-to-day management system. Externally, eco-efficiency could be supported in the company's environment or sustainability reports described in the GRI and the INEM, and provide comparison between companies in the same industry groups over time. Therefore, SMEs may evaluate and consider eco-efficiency if they want to know sustainability for their environmental performance. The generally applicable MPIs and OPIs needed to evaluate eco-efficiency, which can be considered in SMEs are:

MPIs:	OPIs:
- Quantity of goods	- Energy consumption
Net sales	- Material consumption
- Gross margin	Resources consumption such as water

- Unit price

-Greenhouse gas emission (GHG), ozone depleting substance emissions (if possible).

Eco-efficiency ratio can be calculated as the following

$$\frac{\text{mass of product sold or sales}}{\text{Resource consumption (energy and material)}}$$

As a result, SMEs can evaluate and report several kind of eco-efficiency information over time, such as mass of product per material consumption, net sales per greenhouse gas emissions. SMEs should devote themselves to the following actions in order to improve eco-efficiency.

- reduce material, energy, dispersion of hazardous substances;
- enhance recyclability;
- maximize use of renewables;
- extend product life; and
- increase service.

SMEs should consider and develop methods to evaluate eco-efficiency in association with their characteristics, so that they can cope with the strong pressure from diverse interested parties on the sustainability on their environmental and business areas, and move towards sustainable development. They can also use eco-efficiency reporting as benchmarking in order to identify potential improvement opportunities and document progress.

7.3 Implementing EPE in several Industries of SMEs

Large and global companies in the following industries, utilities; food manufacturing; beverage and tobacco product manufacturing; petroleum and coal products manufacturing; chemical manufacturing; computer and electronic product manufacturing have not only implemented diverse environmental management system tools such as EPE, Life Cycle Assessment (LCA), and Design for Environment (DfE), but also attained economical benefits and sound environmental accomplishment generated from them. Today, global environmental issues, such as global warming, climate change and exhaustion of natural resources, have been discussed as sensitive and serious disputes, including diverse proactive solutions on such issues in around the world. Because of these trends, many interested parties such as government, non –

government organizations, stakeholders, and consumers, require all kind of industries to implement EMSs and disclose their environmental information and results related to them their activities, product, and service through reporting regular environmental performance reports. In addition, many large and global companies voluntarily require their branch companies, subcontractors and contractors, or other companies in similar industries around the world to establish and implement environmental management system like ISO 14001, and report their environmental performance. Most of them are small and medium size enterprises, and they need to properly respond and meet their customer's demands. If SMEs in the six industries above and their subcontractors and contractors establish and maintain appropriate environmental management system and environmental performance evaluation according to their characteristics, they can satisfy with environmental requirements of their customers and diverse interested parties.

7.4 Applying and Reporting Environmental Performance evaluation in SMEs.

Although the main purpose of EPE is to collect environmental performance for internal management, the results of EPE can be provided and interpreted as a company's environmental or sustainability reports. The contents and format of the EPE reports may differ depending on various audiences and the aim of the EPE. In addition, a few sustainability reporting guidelines, such as the GRI Guideline, the INEM, and ISO 14031, do not specify reporting requirements for SMEs. Accordingly, SMEs do not have to follow their reporting guidelines even though they use some indicators mentioned in them. They can create those EPE reports in terms of their characteristics, such as size, interested parties, and environmental activities, products, and services, based on the existing guidelines after answering to the following questions:

- What do specific audiences want from the company?
- What is the goal of reporting?
- What is the added value for the company of reporting eco-efficiency?
- Should the information be evaluated and verified by an independent third party to improve credibility with an audience?
- What is the best method of communication? (e.g. paper reports, Internet)
- Should a company provide benchmarking information

- What is the environmental, human, health relevance, and scientific basis of the data?

Scope and limitation should be defined to provide accuracy and precision; the degree to which data have been aggregated; boundaries of data collection; environmental relevance; and the influence of market change. This information may affect audiences to understand the nature of the information provided.

SMEs should follow the general guidelines for reporting and communicating EPE report as described in ISO 14031, because they are accepted around the world. SMEs can have two types of EPE reports, internal and external reports, and communicate and review regularly.

Internally, SMEs should report or describe the following information in their environmental performance reports:

- Trends of the company's main environmental performance indicators, MPIs and OPIs over time;
- compliance with legal and regulatory;
- cost savings or costs expenditure; and
- opportunities or recommendations to improve the company's environmental performance;

If the SMEs implement ISO 14001, they can integrate the system and element of EPE report into ISO 14001 4.6 Management Review.

Externally, SMEs should include the following information in their environmental performance reports:

- an organization's profile;
- the results of MPIs and OPIs ;
- a statement of the organization's commitment to EPE as part of environmental management;
- a description of its activities, products, and services;
- significant environmental aspects and related indicators for EPE; and
- contribution of environmental management and EPE to the overall success of the organization.

If SMEs effectively implement EPE, they can implement substantial environmental performances by the following:

- Determining any necessary actions to accomplish its environmental strategies, objectives and targets