

# Supply Chain Environmental Management: Beyond Supplier Involvement

**Chen-Lung Yang**

Department of Technology Management  
Chung-Hua University, Taiwan  
clyang@chu.edu.tw

**Chin-Huang Lin**

Department of Technology Management  
Chung-Hua University, Taiwan  
chlin.ms85g@nctu.edu.tw

## Abstract

The concept of working with supply chain parties to improve manufacturing sustainability is referred to as Supply Chain Environmental Management (SCEM) or greening the supply chain. Several leading companies (e.g., Xerox, GM) have shown that SCEM can bring not only environmental benefits but also business benefits. The literature has established the premise that supplier involvement can play an important role in a successful EM. Meanwhile, there is emerging evidence indicating that a successful EM program may need support or participation from other supply chain partners. This paper proposes that companies must include not just suppliers, but customers, peers, government, and the community. SCEM is a new paradigm implying that companies wanting to reap the greatest benefits from their EM processes must integrate other members of the supply chain into these processes. The preliminary result of a case study shed light on what supply chain partners could get involved in a firm's environmental management. A discussion of what managers could do to promote the collaboration with supply chain partners in improving environmental management is also offered.

## 1. Introduction

The world economy has seen tremendous growth in the past few decades due to the availability of new technologies and international trade opportunities. Unfortunately, serious environmental problems have evolved from this economic growth. Issues such as depletion of the ozone layer, rapid disappearance of rain forests, pollution of air and water, and scarcity of landfills pose threats to the global quality of life. As a result, environmental management (EM) issues have become extremely important in recent times due to their high level of visibility [30], and managers are assigning increasing importance to environmental issues. For instance, Murphy et al. [22] found that 60 percent of a group of 133 managers surveyed considered environmental issues to be highly important and 82 percent expected that the importance would further increase in the years to come. Larson, Olsted, Teisberg and Johnson [17] studied the opportunity and value created by sustainable business and concluded that EM is not likely to be a fad; instead, it is going to resemble the quality movement of the 1980's.

The purpose of EM is to adopt business strategies and activities to meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be

needed in the future. Overall, the factors pushing the increasing development of EM are from two sources: external and internal. External forces for EM include regulations (e.g., "Product Take-Back and Waste Management" in Europe), customer demand, investors and shareholders. Internal forces include corporate image, concern for environmental impact, and financial benefits. Currently, the development of green procurement around the world can be divided into three types.

- (1) Government Green Procurement Provisions drafted by national and local government departments, for the overall benefit of the environment and for greater competitive strength. Such provisions have already been enacted in all government offices of the European Union and Japan.
- (2) Spontaneous civil organizations, brought together for the public good, for the sake of image bolstering, or for commercial reasons, such as associations include Green Procurement Groups, or Green Procurement Alliances.
- (3) Internal procurement networks built up by multinational enterprises or brand-name companies—such as those of Sony, HP, Dell, Nokia, Simons, Microsoft, IBM, etc.

In response to such trend, managers have developed a diverse set of initiatives to improve the EM, or the sustainability of their products and service. Kopicki et al. [15] classified all initiated into three approaches: *reactive*, *proactive* and *value-seeking* approach. Under the reactive approach, companies commit minimal resources to environmental management as they start to procure some products with some recycled content, start labeling products that are recyclable and use filters to lower the environmental impact of production. However, filters are an "end of pipeline" initiative used to comply with environmental legislation that do not take away any of the causes of the environmental impact. Next, with proactive approach, companies implement new environmental laws voluntarily with modest resource commitment by initiating recycling of products and designing green products in this approach. Additionally, the company assumes responsibility over product re-use and recycling as a part of its environmental program. Finally, with the value-seeking approach, companies seek specific environmental advantages as well as integrate environmental activities in their business strategy and operate the firm in such a way that it reduces its impact on the environment as a strategic initiative. Environmental management presumes supply chain responsibility as

opposed to ad hoc and fragmented organization or functional silo organization. Walley and Whitehead [31] exemplified this approach as systematic, through the strong commitment and integration of flexible strategies and structures, throughout the supply chain. Table 1 summarizes the goals, activities, organizational structure and resource commitment associated with those three approaches.

*(Insert Table 2 about here)*

As companies are moving toward value-seeking approach, they no longer consider EM investment as the tradeoff for financial performance. Shrivastava [29] found the connection between environmental technologies and competitive advantage. Russo and Fouts [26] argued that EM would induce “organizational advantages” and ultimately, “it pays to be green”. Klassen and Whybark [14] found that control-oriented environmental technology improved environmental pollution, while prevention-oriented could actually lead to improvement in manufacturing performance such as cycle time and cost. Xerox targeted achieving “waste free plants” which resulted in pollution control, sales growth and customer satisfaction [19]. Clelland, Dean and Douglas [7] surveyed 250 U.S. manufacturing firms and the statistical results supported the financial benefits of value-creating environmental technologies (e.g., at the source). King and Lenox [13] suggested a relationship between lean manufacturing and EM and there was no tradeoff between manufacturing and environmental performance.

While some of EM initiatives focused on effort within organizations, some of them are related to other organizations or supply chain partners [4][5]. The concept of working with other supply chain parties to improve sustainability is referred to as Supply Chain Environmental Management (SCEM) or “greening the supply chain” [18]. Specific examples of SCEM include screening suppliers for environmental performance, providing training to build supplier EM capacity, and developing reverse logistics systems. Since much of the potential for improving the environmental performance of the products lies downstream in the supply chain, firms are compelled to include suppliers if they want truly environmental friendly practices for purchasing and material management. Managers have examined ways in which suppliers are going beyond merely providing products, services, and materials to actively meeting the needs of companies and participating in forming solutions.

The extant literature, however, focuses primarily on the collaboration from suppliers and little has been discussed in regard to the involvement from other supply chain parties. For example, Handfield et al., [11] suggested that successful EM must integrate all stages of the value chain, including product design, procurement, manufacturing and assembly, packaging, logistics, and distribution. Managers must anticipate and pre-empt changing environmental regulations and customer expectations, and proactively prepares products,

processes, and infrastructure. To be more proactive with EM, managers within the value chain must work together. No specific suggestions, however, have been offered as to what and how firms could collaborate with other supply chain partners.

This paper proposes that companies must include not just suppliers, but customers, peers, government, and the community. SCEM is a new paradigm implying that companies wanting to reap the greatest benefits from their EM processes must integrate other members of the supply chain into these processes. In other words, companies should employ the expertise of their supply chain partners in developing innovative products with improved environmental qualities. As an exploratory study, we intend to address the following research questions.

- (1) Participants of SCEM. What supply chain partners, in addition to suppliers, could be and should be involved in EM collaboration?
- (2) Nature of the participation. What can managers do to promote EM collaboration between supply chain partners?
- (3) Supply chain partnership and EM strategy. How is supplier involvement different between prevention and control types of EM strategies?

The next section reviews the literature on SCEM. A case study is performed to investigate the current SCEM practices followed by the analysis of the case results to address the research questions. Accordingly, research propositions are formed with the discussion of managerial implications.

## 2. Literature Review

Early SCEM studies focused on the effect of purchasing activities, since purchasing function is in an advantageous position to coordinate interorganizational EM effort. Green, Morton & New [10] used a case study to demonstrate the positive effect of green purchasing on the EM performance. Min and Galle [21] surveyed 527 firms on their greening purchasing practices. They found many firms are reactive in adopting greening purchasing strategies and purported that there are immense economic benefits associated with greening purchasing. For example, environmental initiatives to meet “design for disassembly” and reverse logistics in Europe have provided these firms with distinctive advantages in transport, inventory management, and packaging, which are less easy for competitors to imitate.

The collaboration with suppliers later went beyond purchasing activities as the SCEM concept continued to evolve. Numerous studies have pointed out the importance of supplier partnership to EM (See, for example, [1][3][9][10][12]). Since 1990s, suppliers have been touted as a primary source of product and process innovation in developing an effective EM program in a manufacturing firm.

Supplier relationship is always an important

management issue in the automotive industry and naturally it is also where the SCEM practice originated. Lamming and Hampson [16] used the British automotive manufacturer Rover as an example to illustrate how both manufacturers and suppliers could benefit from EM collaboration. They discussed how some companies employed environmental purchasing to gain competitive advantage. They also suggested that SCEM could suffer from poorly-organized information and too many barriers to communication. It is part of the supply chain management philosophy that costs and benefits increasingly dependent on each other for their mutual survival. Lippmann [16] reported the activities some leading companies engaged in to influence their suppliers, the characteristics of effective supply chain environmental management programs. He provided a list of collaborative activities that leading companies (e.g., GM, Nike) conducted to improve their EM. He also identified critical factors (communication, leadership) of effective SCEM and suggested that EM within is challenging and it is even more difficult to do it outside of organizations. Geffen and Rothenberg (2000) used the example of automotive paint process to illustrate how manufacturers collaborated with suppliers to create innovative process for better environmental and financial performance. It is important that both sides develop trust to facilitate the information sharing and technological collaboration.

Handfield, et al. [11] analyzed the EM strategies of five furniture firms and identified the role of different stakeholders in the value chain. Walton, Handfield and Melnyk [31] showed that purchasing can increase its impact on EM through several approaches: (1) Materials used in product design, (2) product design process, (3) supplier process improvement, (4) supplier evaluation, and (5) inbound logistics processes. McIntyre, Smith, Henham & Pretlove [20] discussed how the environmental bias in Xerox was developed and used to measure the environmental performance for the entire supply chain. Geffen and Rothenberg [9] performed three case studies of U.S. assembly plants and found suppliers often have greater access to external knowledge and experience with various environmental innovations and improvement. As companies shift from reactive to proactive EM policies, they need to rethink their product and process by drawing on outside expertise to expand their experience base and competencies. Wright and Peattie [31] discussed the benefit of getting suppliers involved in new product design. Customer-supplier relationship will involve joint projects and designs of processes and products, requiring participation with internal design teams from both these groups. Sharing and integrating environmental ideas and concerns across organizational boundaries will greatly enhance the abilities of manufacturing function to remain green.

More recently, an increasing number of researchers began to investigate possible EM involvement from supply chain stakeholders other than suppliers. Carter and Carter [4] investigated how interorganizational coordination through purchasing function facilitated EM

activities. It could help managers to identify external trends and to respond by adopting suitable strategies. They proposed a framework that illustrates how government, competitors, customers, and suppliers affect environmental purchasing activities. Their results indicated that SCEM activities should go beyond the scope of the purchasing function, and the purchasing department should coordinate closely with internal and external functions. The output section was found to have greater impact on EM. They suggested that companies should begin to direct more attention toward downstream SC members, such as offering distinctive product designs, developing and deploying new technology, increasing public relations and green marketing activities and establishing closer relationship with channel members. For instance, managers are turning to the role their suppliers' policies and practices play in the products that the firms ultimately deliver. For example, S.C. Johnson convened an environmental symposium with 57 suppliers to assess the potential barriers to making environmental improvements throughout the supply base. Klassen and Vachon [13] classified supply chain activities into collaboration and evaluation and assessed the linkage with suppliers and customers. They found that both customer- and plant-initiated collaboration (but not evaluative) affected EM investment. Also, they found the EM programs initiated by customers encouraged prevention investment.

In general, the literature has established the premise that supplier involvement can play an important role in a successful EM. Leading companies have shown that SCEM can bring not only environmental benefits but also business benefits. Meanwhile, there is emerging evidence indicating that a successful EM program may need support or participation from other supply chain partners such as customers, government, logistics providers, etc. The extant literature has not addressed the collaboration with those supply chain entities in regard to the process of obtaining partner involvement, the types of support, and the factors required to develop partnership for SCEM. This study intends to conduct an exploratory study to understand what and how those supply chain entities could contribute to manufacturing sustainability. The analysis is exemplified by using the results of a case study.

### 3. Case Illustration

Company A is one of leading IC manufacturers in Taiwan. It has approximately 9,000 employees in eight wafer fabrication plants. Its total assets are US\$10 billion and sales reached approximately US\$ 2 billion in 2003. Figure 1 lists the supply chain system of Company A. It receives IC designs from clients in consumer electronics, telecommunication, and PC industries. A fabricates the IC wafers

In this study, we are interested in the interactions between the company and its supply chain partners and how they work together to improve the manufacturing sustainability. Data collection for this study utilized

structured interviews in a field setting to ensure that the same data were collected at all sites. A case study protocol was designed and used to guide the structured interviews and data collection [32]. It consists of questions pertaining to company background, business environment information, environmental proactivity, environmental technologies, environmental performance, and supply chain interactions. Appendix lists the outline of the protocol. The protocol was reviewed by two university researchers who are familiar with the environmental management and supply chain management. It was then pre-tested by two senior managers in IC industry. A pilot study conducted to review the research propositions improved the conceptual understanding of the research issues. Based on the results of the pilot study, several protocol questions were rephrased to improve clarity. The interviewees also made several suggestions to enhance the interview method.

Data collection relied on multiple sources, including interviews, direct observation, documentation and archival records. On-site interviews and observations were conducted after the pilot case study was concluded. Prior to the interview, the protocol questions were shared with the interviewees for the purpose of their preparing and gathering necessary information. The respondents were also informed of the purpose of the study. We met with two interviewees, including plant managers and environmental manager, in order to reduce confirmation bias. The first researcher wrote up notes from the visit and the second researcher verified those notes. Disagreements were handled by follow-up telephone calls. Sources of data collection included interviews, direct observation, documentation, and archival records. While most of the data were qualitative in nature, quantitative data (e.g., waste reduction, recycle percentage) were also collected to verify the findings. The use of multiple sources of evidence enhanced both the reliability and validity of this study.

## 4. Research Findings

### 4.1 Environmental management systems

Company A has always embraced self-directed environmental protection as its business philosophy. Over the last three years (2002-2004), the company has doubled its investment on environmental management. For example, the company bought advanced technology to reduce the wastewater that contained organic solvents, and recycled waste phosphoric acid to reduce the amount of sludge, and the recycle rate of harmful business wastes has reached 98%. The company is ISO 14000 certified and has been awarded many times by the government for its distinguished record in environmental management. Figure 1 displays the company's supply chain system, while Figure 2 displays its current EM systems. Based on the information collected, Company A has an EM strategy that falls between proactive and value-seeking categories (See Table 1).

*(Insert Figure 2 about here)*

In general, Company A intends to design an EM system that fits clients' needs and is in step with international trends in sustainability. Table 2 summarizes the involvement from various supply chain parties. Obviously, the number of parties involved in Company A's EM is more than that in the production and service systems presented in Figure 1. The remainder of this section discusses the EM partnership that Company A has developed.

*(Insert Table 2 about here)*

### 4.2 EM partnership

**Clients.** Company A is an OEM of many international large PC firms (e.g., Dell, IBM, Apple, TI), telecommunication firms (e.g., Motorola) and consumer electronic firms (e.g., Sony). Naturally those multi-national organizations have specific environmental requirements for their suppliers. Take Sony as an example. Sony established a green partnership program to formally impose requirements on its suppliers to enhance its environmental quality and safety of all materials used in products sold or distributed in the world. The company clearly specifies restrictively-used substances in purchased parts and the devices used to produce those parts. Suppliers must sign up a "Green Partner Environmental Quality Approval Agreement" and compliant with environmental regulations. All suppliers, including Company A, are required to work with Sony to obtain its "Green Partner" certification. While not all clients have impose such requirement, most of Company A's clients have various initiatives to ensure the environmental compliance of suppliers.

**Suppliers.** Company A has taken a proactive stance in EM toward its suppliers. In 2004, all suppliers are required to participate in the kick-off meeting and sign the cooperative agreement of sustainability. Suppliers must supply required data on any use of hazardous substances in raw materials and production procedures. Meanwhile, Company A has provided suppliers with on-site training and education to achieve higher level of collaboration, including developing alternative chemistries, achieving process optimization, reducing PFC emission through the implementation of point-of-use abatement, fueled combustion, and catalytic composition.

**Competitors.** Company A collaborates with other IC firms through the participation in Taiwan Semiconductor Industrial Association and World Semiconductor Council. By working with both organizations, Company A and other IC firms are able to develop advanced measure technique and various environmental standards.

**Government.** Other than developing various environmental regulations, several government agencies have assisted Company A in complying with the regulations. For instance, Industrial Development Bureau, Ministry of Economic Affairs (MOEA) invited Company A to participate in Green Productivity Demonstration Program through which the company received valuable

suggestions on developing the infrastructure necessary for its EM system.

**R&D institutions & communities.** Company A has made tremendous amount of efforts to combine environmental protection with its concept of corporate citizenship. It has actively participated as a Corporate Citizen in environmental protection social activities, such as the Environmental Protection School Children's Activity on Earth Day, and the Beach Cleaning Activity in the local community. Furthermore, the company has set up a foundation to support various environmental education programs in the local community. These activities demonstrate to the public the company's belief in its sense of responsibility towards environmental protection. Company A also works with various R&D institutes to develop environmental technologies and management systems. For instance, the company currently collaborates with a local university to establish the environmental accounting system to be able to track its EM activities.

## 5. Conclusions

SCEM proposes a new model for the relationship between companies and their suppliers. We should examine ways in which supply chain partners are going beyond merely providing products, services, and materials to actively meeting the needs of companies and participating in forming solutions. Overall, SCEM merges a firm's environmental management policies and goals with its SCM programs. The implementation of SCEM implies that companies wanting to reap the greatest benefits from their EM processes must integrate other members of the supply chain into these processes.

This study performs a case study to investigate the participation of various supply chain parties in an organization's EM activities. The following is the summary of our findings.

- (1) A company with value-seeking EM strategy involves various supply chain partners other than suppliers.
- (2) The level of supply chain participation is likely to be associated with the EM strategy. Figure 3 is a proposed relationship between supply chain partnership and EM strategy. Obviously, more studies are necessary to confirm this association.

*(Insert Figure 3 about here)*

More information has been collected from other companies that implement various strategies with different levels of SCEM participation. The ultimately goals of this project are to confirm the value of SCEM and to enable managers to establish effective SCEM.

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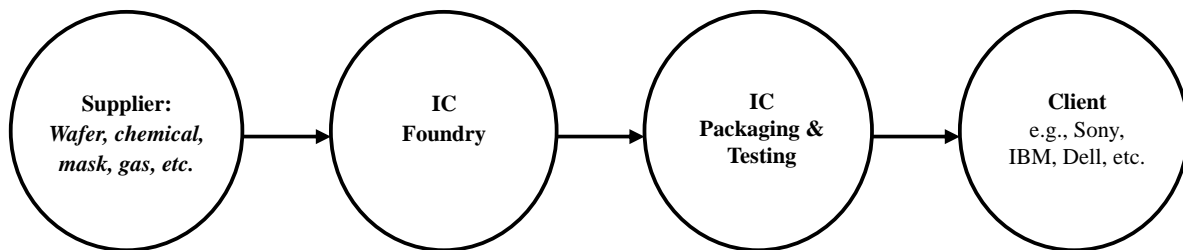


Figure 1. Company A's Supply Chain System

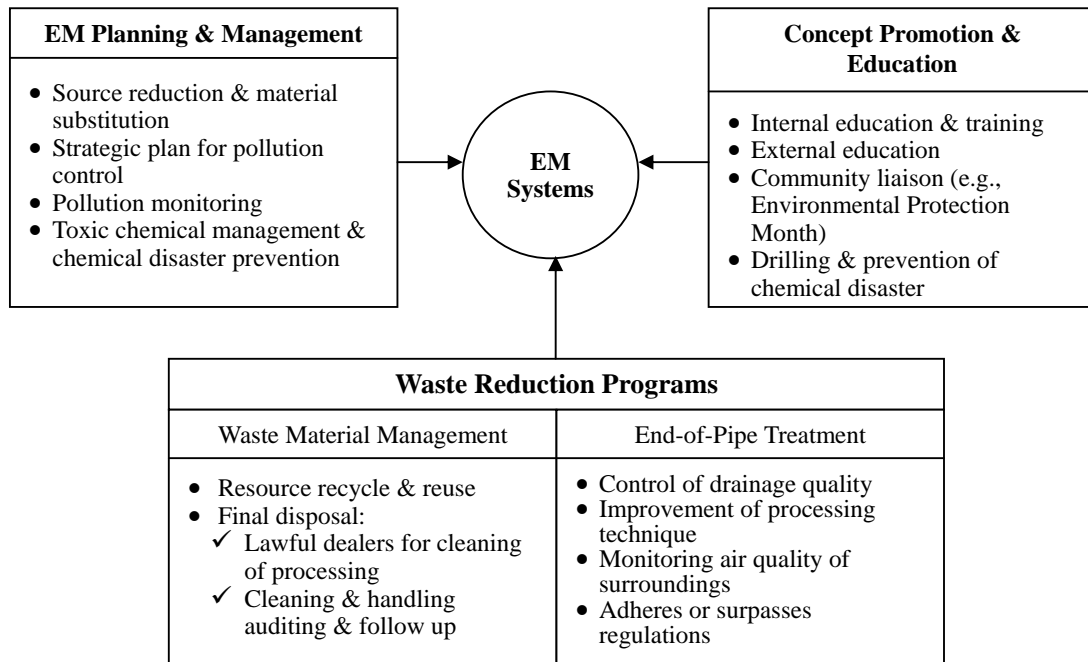


Figure 2. Current EM Systems

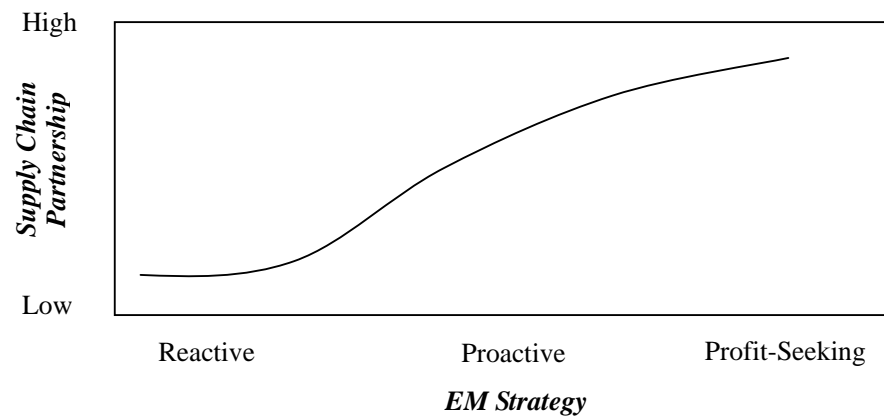


Figure 3. Supply Chain Partnership and EM Strategy

Table 1. EM Strategy Classification

| Characteristics          | EM Strategy   |  |  |
|--------------------------|---|--|--|
|                          | <i>Reactive</i>   | <i>Proactive</i>   | <i>Value-Seeking</i>   |
| Primary EM goals         | (3) Comply with existing laws<br>(4) Fulfill Individual environmental commitments.<br>(5) Achieve a cost savings  | 1. Attempt to prevent new environmental laws by voluntarily starting environmental programs.<br>2. Develop competitive advantage through more efficient compliance   | 1. Put environmental activities into a business strategy<br>2. Operate the firm to reduce its impact on the environment  |
| Primary EM activities    | 1. Procure products with recycled content.<br>2. Label products that are recyclable, contain recycled material, or have other environmental benefits  | i. Prepare corporate environmental policy statement, define goals of environmental program, and conduct environmental audit.<br>ii. Assume responsibility for product reuse and recycling through industry alliances and reverse logistics systems | 1. Use environmental life-cycle analysis to evaluate products and packaging, using the results to help design products to be reused, recycled, and disassembled<br>2. Critically review existing processes and products/services asking suppliers to commit to waste reduction goals.<br>3. Develop internal company incentives and enforcement procedures |
| Organizational structure | 1. Usually an ad hoc and decentralized organizational structure.<br>2. Responsibility falls on individual who initiates the program. In cases where the program is in reaction to laws, the government compliance office has responsibility | 1. Commitment of CEO and other top managers.<br>2. Broad communication of program objectives to all employees.<br>3. Managers may have any background, from public relations to merchandising to packaging or logistics.                           | 1. CEO and other top managers establish strong environmental commitment throughout the organization.<br>2. Interdepartmental teams help set policies and identify areas for improvement.<br>3. Waste reduction managers coordinate and implement policies throughout the firm  |
| Resource commitment      | 1. Minimal.<br>2. Compliance costs vary by location   | 1. Modest.<br>2. Possibly seek to avoid high costs by entering into joint ventures or industry coalitions.   | 1. Resources dedicated to the program become an integral part of all the company's operations.<br>2. Capital exposure is often limited by strategic alliances and partnerships with third parties  |

Table 2. SCEM Partnership

| <i>Supply Chain Member</i> | <i>Collaboration</i>  |
|----------------------------|---|
| Customers                  | Restructuring relationships, Site visit, audit, survey, Sony green partner.   |
| Suppliers                  | 1. Draft a document elaborating clearly A's Green Procurement standards related specifications.<br>2. Set up a Environmental Hazardous Substances Control List along with control standards.<br>3. Set up an Environmental Evaluation Checklist for A's suppliers.<br>4. Complete A's Supplier Environmental Protection Data Check and sign declarations stating that there are "no hazardous substances used."<br>5. Strengthen current electronic supplier management system, adding a search function for supplier's environmental protection data and declaration management features.<br>6. Verification of harmless product and production process.<br>7. Educational training. |
| Competitors                | Collaborated with other IC firms, through World Semiconductor Council and Taiwan Semiconductor Industrial Association, to develop advanced measure technique.   |
| Government agencies        | Established Green Productivity Demonstration Program to offer free assistance in developing necessary infrastructure.   |
| R & D institutions         | Developed various pollution reduction equipment and techniques.   |
| Communities                | E-Foundation, Various community activities: hiking, beach clean up  |