A Study of Green Procurement Practices: A Case Study of the Computer Parts Industry in Thailand

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***Abstract*— Over the last few decades, manufacturers have developed the green concept in their supply chain management to focus on environmental issues. Customers are becoming more environmentally concerned and the government is considering and developing environmental regulations. The main aim of this research is to explore current processes and activities of green procurement management in the computer parts industry of Thailand. Case studies of this research are 5 manufacturers in the computer parts industry in which in-depth interviews and unstructured questionnaires are used to find out the current situation, processes and activities of green procurement management. The results of the research, interesting situations and direction of the computer parts industry are found. The proposed results of this research will help to understand more about green procurement management in the computer parts industry in Thailand and could provide further direction for researchers and practitioners in the computer parts industry.**

Keywords*— *Green Procurement, Green Supply Chain, Electronics Industry, Computer Parts Industry

I. INTRODUCTION

Green supply chain concept has been increasing amongst academia and industry researchers in the last decade. Many manufacturing industries applied the green concept to manage their supply chains, which focused on environment issues [1]. Green supply chain management (GSCM) concepts comprise green purchasing, green manufacturing, green distribution and reverse logistics. GSCM is an integrated process from the raw materials to the finished product, distribution of the product to the customer and to the disposal process, which reduces environmental impacts and improves productivity and profitability [2].

Many companies have adopted green supply chain management as one of their important strategies along with policies to reduce environmental impacts and increase competitive advantages by creating a green supply chain network for their stakeholders [3]. Green purchasing plays an increasingly significant role in today's supply chain management. Currently, customers are increasingly aware about green products and require more environmentally friendly products. Supplier relationship management has become an important part of green supply chain management to fulfill the demands

and requirements of customers and improve the efficiency of GSCM [4]. Thailand's electronics industry plays an important role to the country's economy. The total value of exported electronics products was US$ 20.8 million in the year 2014. Computer parts were ranked first in terms of export numbers, with a total value of US$ 11.8 million, representing 56% of the total number of exported electronics products. In recent years electronics manufacturers have faced some barriers such as instability in manufacturing costs, skilled labor requirements, technology changes, exchange rate fluctuations, and the impacts of greater competitiveness, environmental legislation and directives, all of which affected the performance and practice of green supply chain management in the electronics industry in Thailand [5]. This research aims to survey current processes and activities of green procurement management in the computer parts industry of Thailand and to provide a guideline for further directions for researchers and also practitioners in the computer parts industry.

II. LITERATURE REVIEW

A. Green Supply Chain Management (GSCM)

Green supply chain management can be effectively applied to protect and reduce environmental impacts from end of life products that affect society, the economy and the environment in the long-term perspective [6]. GSCM is the process of activities along the supply chain that focuses on environmental impacts such as purchasing decisions strategy and long-term relationships with suppliers [7]. It is an approach for improving environmental performance of processes and products in accordance with the requirements of environmental regulations. Companies need to implement GSCM as a continuous process to achieve sustainability [8].

To achieve sustainable development, supply chains must become greener; GSCM can improve the environmental performance of a company [9]. Toke et al. [10] studied critical success factors of the green supply chain management (GSCM) to select suitable strategies and policies for implementing GSCM in Indian manufacturing by using literature reviews, in-depth interviews and questionnaire surveys for collecting data of the implementation of GSCM in the Indian manufacturing industry. Adarsha and Prathap [11] investigated and studied the relationship between green supply chain management practices and environmental performance of the manufacturing industry in India. Chen and Liang [12] evaluated internal costs and benefits for Taiwanese computer manufacturers after implementing GSCM in Taiwan's computer industry. Choomrit et al. [5] surveyed green activities of computer parts' manufacturers in Thailand. The studies also evaluated and investigated the process of GSCM practices and measured GSCM performance of computer parts' manufacturers from their implementation. Luo et al. [13] studied GSCM collaboration implementation in China with the mediating role of guanxi, which focused on the relationship between buyer and seller, competitive environment and the role of guanxi in affecting the decision of Chinese manufacturers to implement GSCM.

Chien [14] studied green supply chain management practices in Taiwan's electrical and electronics industries that focused on green standards for green supply chain managerial practices such as European Union Restriction of Hazardous Substances Directive (RoHS), Waste Electrical and Electronic Equipment (WEEE) and Eco-design of End Use Equipment (EuE) to protect the environment and adoption of GSCM for Taiwan's electrical and electronic manufacturers. Seman et al. [15] stated that there was a lack of research to adequately examine the adoption and implementation of GSCM practices especially in developing countries such as Malaysia and proposed the research direction for Malaysia's manufacturing industries to implement GSCM.

B. Green Procurement Management (GPM)

Green procurement management plays an important role in today's supply chain management. Many manufacturers have created long-term relationship with suppliers and other manufacturers through the green purchasing process in their supply chain management [16]. Yang and Zhang [17] stated that green purchasing is an important strategy for companies that can help to reduce waste, improve efficiency and enhance competitiveness of an organization. Salam [18] investigated green procurement adoption amongst Thai electronics companies that focused on the relationship between green procurement adoption and product performance, purchase price, the organization's environmental concerns, trading partners, and health and safety issues. The designing of environmentally friendly products and taking back the products and packaging, business can generate benefits to the environment in the form of reduced waste and better resource utilization [19]. Appolloni [20] reviewed literature of green procurement and identified the main themes of Green Procurement (GP) of private sector into 3 themes which are: the motivation and drivers for the implementation of GP, barriers to the implementation of GP and the performance impacts of the adoption of GP. Green procurement is very important to a company in terms of both environmental performance and economic performance. Kannan [21] stated that the selection of green suppliers based on GSCM practices could avoid or reduce toxic hazardous material use. Hamner [22] summarized basic strategies used in green purchasing activities as follows:

1) Product Content Requirements: Manufacturers or buyers must have desirable green raw materials and products from the suppliers that can be reused or recycled.

2) Product Content Restrictions: Manufacturers or buyers specify that products must not contain environmentally undesirable attributes such as avoiding problems associated with using toxic chemicals.

3) Product Content Labeling or Disclosure: Manufacturers or buyers require disclosure of the environmental or safety attributes of product contents such as Green Seal, and indicators of relative environmental impact such as scientific certification systems.

4) Supplier Questionnaires: Manufacturers or buyers ask suppliers to provide information about their environmental aspects, activities and/or management systems.

5) Supplier Environmental Management Systems: Uncertified suppliers, manufacturers or buyers are required to develop and maintain an environmental management system (EMS) that generally conforms to one of the recognized international standards such as ISO 14001. Certified suppliers, manufacturers or buyers require suppliers to have an EMS that is certified.

6) Supplier Compliance Auditing: Manufacturers or buyers audit suppliers to determine their level of compliance with environmental requirements.

7) Supplier Environmental Management System Auditing: Manufacturers or buyers audit not only the compliance status of the suppliers, but also their environmental management system.

8) Buyers Set Their Own Compliance Standards: Manufacturers or buyers develop their own standards for environmental compliance and require buyers to meet these standards and also conduct their own inspections to determine the level of compliance with the standards.

9) Product Stewardship: Manufacturers or buyers take responsibility for managing the environmental effects of products throughout the product lifecycle.

10) Education and Collaboration: Manufacturers or buyers educate suppliers about environmental issues and environmental management strategies and work closely with suppliers to solve environmental problems.

11) Industrial Ecology: Manufacturers or buyers work with suppliers and customers to develop a fully integrated system for recycling and re-use of materials within an industrial ecology framework.

III. METHODOLOGY

This study used both primary and secondary data. Secondary data is based on journals, case studies, and articles which were used as guidelines in the concept of practicing green supply chain management (GSCM) and green procurement management (GPM) in the computer parts industry and other related industries. The concepts are adopted in this study. Secondary data also provides ideas to create a framework for the collection of primary data.

The collection of primary data is based on an in-depth interview and unstructured interview of those involved in the computer parts product industry with a specific focus on green procurement management of 5 case studies: IC, hard disk drive, power supply, printed circuit board and monitor manufacturers.

IV. RESULTS AND DISCUSSION

A. Green Procurement Management of the Computer Parts Industry

In this research, we focused on 5 computer parts manufacturers that are leading producers in Thailand. All of the case studies have the same process of green procurement management. The process of GPM is shown in figure 1.

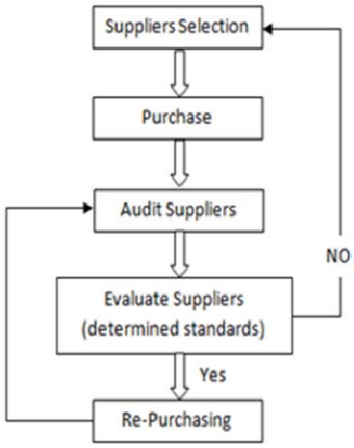

Fig. 1. Green procurement process of computer parts manufacturers

B. IC Manufacturer

The company is the world leader in development and production of semi-conductors of which there are manufacturing bases in many countries. The company has the policy of "Green Procurement" by following SS-00xxx standard (own standard), which is determined to control substances that affect the environment and then eliminate and reduce the substances in the products. Prohibited substances are shown in Table I.

TABLE I: THE LIST OF PROHIBITED SUBSTANCES IN SS-00XXX STANDARD.

Prohibited substances	
1	Metal (lead and lead compound, mercury and mercury compound)
2	Organic substance in groups of Chlorinated (PCB, PCN, CP, Etc.)
3	Organic substance in groups of Brominated (PBB, PBDE, TBBP-A-Bis, Etc.)
4	Organic tin compound (Tributyl tin compound, Tripheney tine compounds)
5	Asbestos
6	Azo compounds
7	Formaldehyde
8	PVC and PVC compound

Green procurement management is the process of purchasing that focuses on environmental awareness. Processes and activities of GPM are:

a) Supplier's selection: IC Company used SS-00xxx to be a standard to select the suppliers for the company.

b) Audit suppliers: The suppliers were audited by the company twice a year for quality assessment. If suppliers passed the audition, they would be promoted to be a green partner of the company.

c) 3Rs: They applied 3Rs to reuse the paper from the documents of the company.

C. Hard Disk Drives Manufacturers

The hard disk drives manufacturers in this case study are the leading manufacturers of the product in Thailand. They can produce products with high quality and an awareness of the environmental impacts. The standards of the production of the first company comprise ISO 14000, OHSAS 18000 and RoHS to be the standard criteria to select suppliers of the company. For RoHS standard, there are various prohibited substances including lead, mercury, cadmium-6, PBB and PBDE. Processes and activities of GPM are:

Supplier's selection: The suppliers of the company were selected by the standards of the company such as ISO 14000 and OHSAS 18000, which were used to consider prohibited substances and that used the rule of RoHR for the process of the selection of suppliers.

a) Audit suppliers: The suppliers were audited by the company twice a year for quality assessment.

b) 3Rs: They used e-mail instead of traditional postal mail and reused and recycled used paper.

c) The second company is the manufacturing base of a Japanese company. They used the ISO 14000 and RoHS to be the standard for suppliers' selection. All of the raw materials of this case study would be delivered from Japan for the production.

D. Power Supply and Printed Circuit Board Manufacturer

The power supply and printed circuit board companies are some of the biggest manufacturers in the world. The headquarters of both companies are in China. For the process of green procurement management, the companies have determined the prohibited substances by themselves in terms of the production and suppliers selection.

TABLE II: THE LIST OF PROHIBITED SUBSTANCES OF POWER SUPPLY AND PRINTED CIRCUIT BOARD COMPANIES.

	Prohibited Substances
1	Heavy Metals (Cadmium and Cadmium Compounds, Lead and Lead Compounds, Mercury and Mercury Compounds, Hexavalent Chromium Compounds)
2	Halogens and Related Compounds (Halogens – PBBS, Halogens – PBDEs, DecaBDE, PVC and PVC Blends, PCB, PCT, PCN, CP, Other Brominated Organic Compounds, Substances Depleting the Ozone Layer, Halogens – Halogenated Dioxins and Furans, Halogens and Related Compounds)
3	PFOS and Related Compounds
4	Organic Tin Compound (Tributyl Tin Compound, Triphenyl Tin Compounds)
5	Asbestos
6	Specific Azo Compounds
7	Formaldehyde
8	Radioactive Materials
9	Phthalates
10	Pesticides

The case studies implemented green procurement management which focuses on quality, price and on time delivery products to the customer and reduces the environmental impacts from the products and services. Processes and activities of GPM are:

a) Supplier's selection: The suppliers will be selected by the standard of the companies which are shown in Table II, as these are the standards and regulations concerning environmental impact of the companies.

b) Audit suppliers: Suppliers will be assessed as to the qualities of green procurement management performance by an auditor of the companies twice a year.

c) 3Rs: The boxes of packaging or other boxes will be reused, and also component parts damaged during the production process will be recycled.

E. Monitor Manufacturer

This case study is of a Thai monitor manufacturer with its manufacturing base in Korea that produces and then delivers products to customers of the company. The company is focused on environmental awareness by improvement of its products and also uses standards such as ISO14000, OHSAS 18000, RoHS and WEEE for production and suppliers selection. Processes and activities of GPM are:

a) Supplier's selection: They will select suppliers who can follow ISO14000, OHSAS 18000, RoHS and WEEE standards.

b) Audit suppliers: Suppliers will be assessed as to their qualities of green procurement management performance by an auditor of the company twice a year.

3Rs: Reused boxes and recycled damaged component parts (plastics).

F. Green Procurement Management standards and practices of case studies

The study of green procurement practices in the computer parts industry of Thailand is focused on their standards and practices in terms of being environmentally friendly. Due to the fact that nowadays customers are found in many countries, so companies have to follow the main standards such as ISO 14000 for their production; a summary of the standards and practices of each of the case studies is shown in Table III.

TABLE III SUMMARY OF STANDARDS AND PRACTCES OF CASE STUDIES

Companies	***Standards***	***Audits***	***3Rs***
IC	• ISO 14000 • SS-00xxx (own standard)	2 times/year	• Reuse • Recycle
Hard Disk Drives	• ISO 14000 • OHSAS 18000 • RoHS	2 times/year	• Reuse • Recycle
Power Supply and Printed Circuit Board	• ISO 14000 • Own standard	2 times/year	• Reuse • Recycle
Monitor	• ISO 14000 • OHSAS 18000 • RoHS • WEEE	2 times/year	• Reuse • Recycle

The case studies show that the companies have practiced following the main required standards and have tried to develop their own rules and standards to respond to the requirements and demands of customers worldwide, who are increasingly focused on environmentally friendly products, because each case study has its own customers in different countries, something that requires them to meet different standards and rules such as European countries (EU) requiring WEEE, RoHS, EuP, REACH, etc. Therefore, each manufacturer buys raw materials and produces products following their customers' standards while for the process of audits, all of the featured case studies are audited for their suppliers' performance twice a year to control suppliers' standards and quality of raw materials. For 3Rs practice, they have each tried to reduce resources of the company by reusing items such as paper, boxes, packaging, etc. and also tried to recycle damaged component parts.

V. CONCLUSION

Green procurement management (GPM) activities of each case study depend on the standards and policies of the company. All of the case studies are major manufacturers of computer parts that have manufacturing bases and customers worldwide. The demands of customers range from European countries, Japan, China and others and are focused on products being environmentally friendly. Therefore, each company has received ISO 14000 standard and also implemented green procurement management to receive green raw materials from suppliers. For audit purposes, each company will audit their suppliers' quality twice a year to control the standard of raw materials and assess performance.

Suppliers selection criteria will depend on the requirements of each company which will consider quality, price, on-time delivery, environmental awareness, etc., by following the main standards such as ISO 14000 and others according to their customers' requirements. Based on the results of this study, some recommendations of green procurement management problems are as follows:

1) Laws and regulation of green procurement management are not efficient or effective.
2) Lack of knowledge of manufacturers to follow global standards such as WEEE, RoHS, etc.
3) Lack of R&D in green procurement management.
4) Lack of government support in green procurement management.

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