

## Research Article

### Green Supply Chain Management as a Conceptual Framework for Taiwan Textile Industry

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**Abstract:** This study introduces the conceptual framework of Green Supply Chain Management (GSCM) for Taiwan textile industry. The qualitative approach is divided into Green Manufacturing, Green Marketing and Wastes Recycling. In order to conquer the trade barriers by the European Union (EU), all works ought to fulfill the requirement of EU environmental directives, including these restrictions of hazardous substances, energy consumption and wastes recycling. The GSCM system is conducted into enterprises with the following job items are completed: First, the information platform is built and regularly being used. Secondly, the technical level must achieve the demands of EU environmental directives. Finally, merchandises should offer test report or authentication on the six restricted compounds.

**Keywords:** Authentication, environmental directives, GSCM, information platform, qualitative approach

## INTRODUCTION

Since the worldwide demand for green products are increasing day after day, green production adopted by manufacturers was paid much attention. It is green supply chain to command the suppliers to provide raw materials, semi-finished goods, or even final products according to the environmental directives. That means supply chain management merges with many environmental criteria and principles in order to make the green products more eco-friendly and more competitively for the worldwide market (Hall, 2000).

Beginning in 2003, some environmental criteria and regulations are promulgated by the European Union. The following three environmental directives deeply affect Taiwan products export to the EU countries: 2003: Waste Electrical and Electronic Equipments, WEEE (European Union, 2003b), 2003: Restriction of Hazardous Substances, RoHS (European Union, 2003a) and 2004: Eco-Design Requirements for Energy Using Products, EuP (European Union, 2005).

Immediately after 2005, the Ministry of Economic Affairs, Taiwan proposed an action program to conform the EU environmental directives, impelled "the Green Project" vigorously to set up a soundly green supply chain system for a variety of industries (Shau and Hsu,

2005). The first be guided is the Electrical and Electronic (E and E) industry with seven companies composed of five Information Technology products manufacturers, the Taiwan E and E member association and testing institution, as shown in Table 1.

First International Company Inc, Taiwan (FIC), one of the seven companies, built up its own Green Supply Chain Management (GSCM) called "FIC Green Project" (FIC, 2005). In the FIC Green Project, each stage of green electronics life cycle should fit the EU environmental directives such as WEEE, RoHS and EuP shown in Fig. 1. Based on this model, the GSCM can be applied to any E and E companies in Taiwan. As for quantitative approach, certain researches for Taiwan E&E industry had been released to evaluate the GSCM performances, such as fuzzy analysis (Che, 2009; Tsai and Hung, 2009) and logistics evaluation (Chan, 2007; Liu and Xiong, 2013). The GSCM application to the E and E industry is still called fullness from the qualitative or quantitative point of view. But not many research cases for other industries are being discussed in Taiwan.

The purpose of this study is to establish a conceptual framework (Sarkis, 2003; Dreyer *et al.*, 2009) standing on the characteristics in the life cycle stages for textiles by following the E and E industry

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Table 1: The first seven companies to be guided by following the green project

Company name	Description
Taiwan Electrical and Electronic Member Association (TEEMA)	Electrical and electronic association
Société Générale de Surveillance in Taiwan (SGS)	Testing institution
Arima Photovoltaic and Optical Corp. (Arima)	I.T. products manufacturer
Accton Technology Corp. (Accton)	I.T. products manufacturer
MiTAC International Corp. (MiTAC)	I.T. products manufacturer
First International Computer Inc. (FIT)	I.T. products manufacturer
ASUSTeK Computer Inc. (Asus)	I.T. products manufacturer

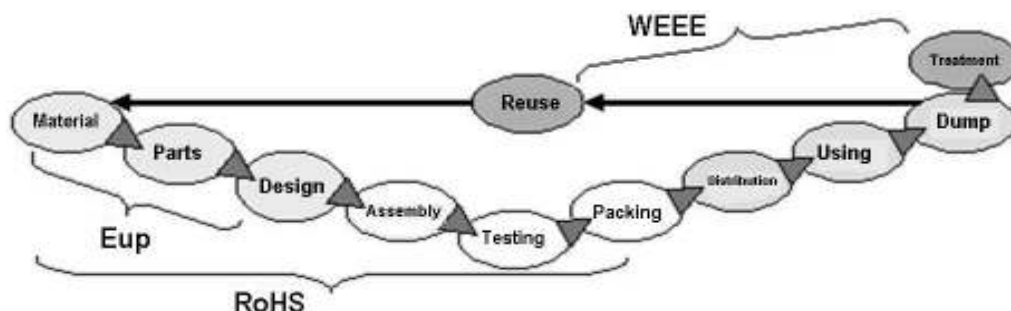


Fig. 1: The green supply chain management of FIC for green electronic products

since the textile industry is still the second large one in Taiwan (Chen *et al.*, 2008). By using this green textiles supply chain management approach, the textile industry has a clear direction to go and has the ability to bring Taiwan into the sustainable textiles. It also advocates the policy of multi-industry green supply chain management instigated by the Taiwan Ministry of Economic Affairs.

### METHODOLOGY

**Research flowchart:** There are four steps in this flowchart which are the planning, establishment, execution and enable. Three steps are planning, execution and enable which were proposed in 1996 by the Supply Chain Council (SCC) for Supply Chain Operation Reference, SCOR (SCC, 1996). While we add the fourth step named the establishment between planning and execution in the flowchart, shown in Fig. 2. The planning step is to plan a system for Green Supply Chain Management. The establishment step is to establish a model of qualitative approach. The execution is to carry out the Green Manufacturing and Green Marketing. The enable step is to make the enterprisers sustainable.

**Qualitative approach:** There are 5 members in a supply chain which are suppliers, manufacturers, distributors, retailers and consumers respectively from the top to the bottom (Lee and Billington, 1992). However the manufacturers again are divided into the OEM (Original Equipment Manufacturing), the ODM (Original Design Manufacturing) and the OBM (Own Brand Manufacturing) which is also called the PB (Private Brand). The qualitative approach for the supply chain management system discussed in this study is to

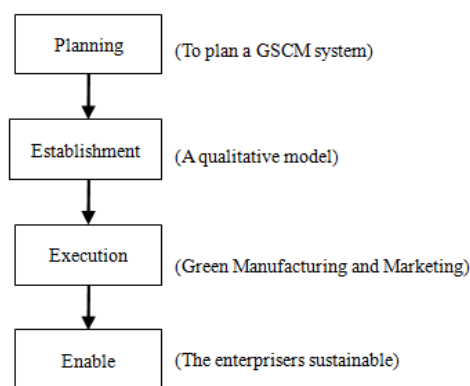


Fig. 2: The green supply chain management research flowchart

form mutual relationships for all members mentioned above and to represent with an abstract graphics as shown in Fig. 3.

**Conceptual framework:** The conceptual framework of Green Supply Chain Management for the textile industry is established by imitating the GSCM conceptual framework represented by the Electrical and Electronic industry (Chen, 2005; Chen *et al.*, 2007). Contents in the textiles are comprised of Green Manufacturing, Green Marketing and Wastes Recycling which are the three stages life cycle of textiles as shown in Fig. 4. Detail interpretation of textiles conceptual framework will be discussed in the next section.

### RESULTS AND DISCUSSION

After 40 years of development, textile industry in Taiwan became very soundly. The process and units for textiles production are the combination of spinning,

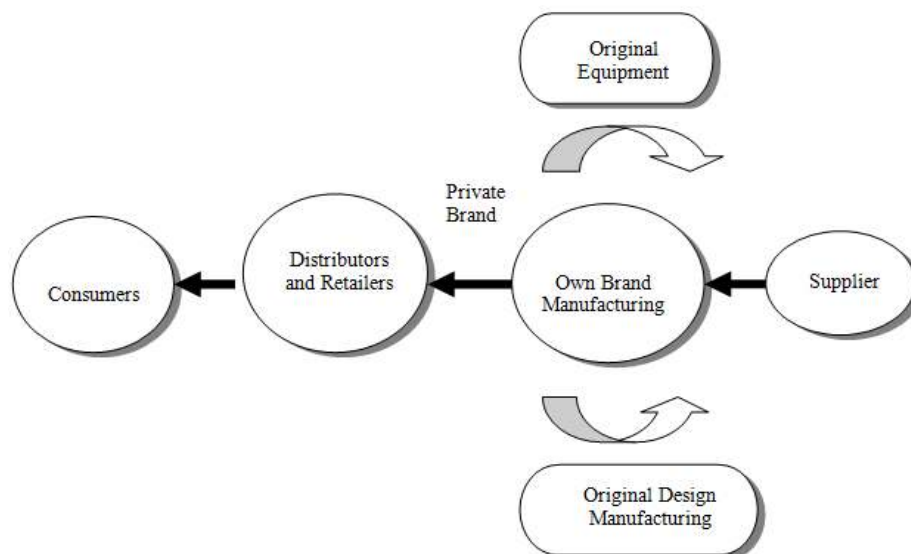


Fig. 3: The mutual relationship of all supply chain members

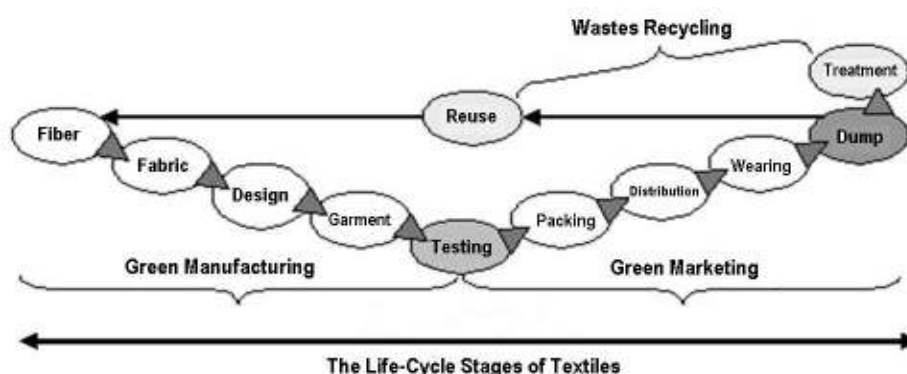


Fig. 4: The green supply chain management of green textiles

weaving, dyeing, finishing, designing, marketing and distributing.

According to the different stages in the life cycle of textiles, the Green Supply Chain Management quantitative approach for textiles is to be set up by embracing the Green Production Management as shown in Fig. 4. There are 11 stages within textiles life cycle, which are fiber, fabric, design, garment, testing, packing, distribution, wearing, dump, treatment and reuse. Fibers, fabrics, designs, garments and tests are categorized as the Green Manufacturing. Packing, distributing and wearing stages belong to the Green Marketing. Treatment and reuse after dump stage are called the Wastes Recycling.

**Green manufacturing:** There are four criteria under the rule of Green Manufacturing, which are green design, green purchase, green production and green testing. Five stages of Green Manufacturing coming out of the life cycle of textiles can be co-related to these four criteria.

**Green design:** Any stage in the life cycle of textiles could have the possibility to impact the environment by the time the Green design was well organized. The preventive manners are to take “Three-low” at the very beginning of the Green Supply Chain Management. The Three-low means low toxicity, low energy consumption and low material resources.

**Green purchase:** Under the regulation of RoHS, any textiles cannot have lead, cadmium, mercury, chromium with a valence of six ( $Cr^{6+}$ ) and bromine-containing fire resistant reagents (PBB, PBDE). It is green purchase that we should ask the suppliers to provide certificates to prove their materials without any restriction of hazardous substances.

**Green production:** In addition to the three-low prevention, textile commodities after mechanical and chemical processing must not cover the four heavy metals and two bromine-containing reagents. Green production as well as green purchase is under the rule of EU environmental directives.

**Green testing:** The government shall impel textiles association and testing institution to build up the authentications of testing methods and standards for RoHS then issue official documents. Together with ISO and OHSAS, total of three authentications make the textile end-product be qualified for exportation to EU Economic Community.

**Green marketing:** Once these textiles achieved an authentication with certificates, we could put the information of green textiles into the database of electronic commerce platform to the public for business. It is the Green Marketing that the exchange platform is open as a reference for either suppliers or buyers who may have interest to deal with one after another and carry out the business. The e-commerce and exchange platform for a supply chain system is good for all suppliers, manufacturers and buyers that any information on this platform must be exposed in an official authentication.

**Wastes recycling:** We shall consider how to dispose dumps by the time the textiles were made and sold. Either treatment or reuse for textile wastes must have a joint operation with local regenerators at the region of end-use consumers. For example, polyester fiber (commercial name Teton) after recovered from T/C textiles need to be ground and then mixed with raw polyethylene terephthalate to form PET bottles for beverage. When the wastes regenerators are fully cooperated with the textiles manufacturers, this recycling system then set up and operation.

## CONCLUSION

**Survey current textiles:** Textile industry in Taiwan is good at productivity, integrality, cost, substitute production and designs. For years, we produced No. 1 in Polyester and No. 2 in Nylon in the world. The fiber materials of textiles were abundant and cheap. The integrality of textiles is from synthetic fiber, mechanical and chemical processing, producing garments then wholesale since they are all closely related and combined together. The Original Equipment Manufacturing (OEM) was Taiwan industrial specialty at the time industries begun. Nowadays, textiles in Taiwan are improved and progress the attributes onto the Original Design Manufacturing (ODM) or even to establish an own brand or private brand as shown in Fig. 3.

Low toxicity, low energy consumption and low material resources were only fundamentally demand. Furthermore, environmental management such as ISO 14000 and occupational health and safety such as OHSAS 18000 are eagerly propagated. Both fundamental and remarkable improvement of tasks had

already been applied to the green textiles production in Taiwan.

**Sustainable development textiles:** Today, there are three global economic regions came into reality, including European Union, North America and Chinese Economic Area (CEA). Previous Industries models all focused on the Sequential Optimization by regional markets, which are regional subscribers and local materials in Taiwan. In the future, we shall pay much attention on Supply Chain Management slowly but surely and match up the Global Optimization by global markets, which are materials in the upstream, manufacturers in the midstream and customers in the downstream.

Textiles in Taiwan are now facing variety of competitors, both at domestic and abroad. In order to get more additional values, green textiles need to take some innovations and creations to enhance the competition, from the Original Design Manufacturing (ODM) to the Private Brand, Own Brand Manufacturing (OBM) in the future.

Some specific EU environmental directives, like the RoHS, could give textiles to make up the deficiency of eco-friendly low toxicity. The EuP directive shall have comprehensively considered energy to be used at the very beginning of industrial eco-design, regardless of wastes recycling, reuse, recovery or decomposition in the final stage of life cycle to support this green textiles sustainable development.

## RECOMMENDATIONS

There will be some important agenda need to be worked out for Taiwan industries Green Supply Chain Management, in addition to the textiles:

- Does the technical level research the demands of EU environmental directives?
- Information platform should function perfectly at interaction response (Cecil *et al.*, 2006).
- If the suppliers provide unreliable test reports or authentications, it could result in some unexpectedly risks.
- Since the manufacturers must offer product tests, it certainly becomes inexpensive.
- Customers of well-known companies may ask the manufacturers to pay the test cost.

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