Practices and Innovation of Green Supply Chain

1. Background and Research Objectives

1.1 Background

On February 15th, 2011, Apple Inc. issued its Supplier Responsibility Report 2010 and reported that 137 workers at a supplier factory in China suffered adverse health effects following exposure to a chemical cleaning agent.On August 31st, 2011, a group of Chinese NGOs issued a report accusing more than a dozen suspected China-based Apple suppliers of making unlawful discharges and polluting the ambient environment. These reports aroused extensive attention both in China and the international community.① In 2008, a number of Chinese enterprises and transnational companies including Mengniu, Yili, Nestle, Cadbury and Starbucks were affected by supplier factories that were producing Melamine-tainted Milk Powder. These events, and others like them, have spotlighted the risks of supply chain management. In these cases, not only has public health been endangered, but the supplier companies and their multinational clients have suffered economic and reputational losses.

Under the backdrop of globalization, green supply chain management is recognized as a direct and effective mechanism to address environmental problems along the global value chain. Using the purchasing power and consumption behaviors of governments, large enterprises and the public, green supply chain management is a market mechanism for reducing pollution and improving energy and resource efficiency. When combined with effective enforcement of national and regional environmental laws and policies, it can result in the green transformation of entire industry sectors. Green supply chain management can be an innovative tool for environmental management. This works

① Apple Inc. communicated with the research team of this CCICED report and stated that less than 50% of the listed suppliers in the NGO's report are actual Apple suppliers. According to Apple, Apple is in communication with those NGOs and is using expert third party auditors to audit those Apple suppliers identified in the report and intend to work intensively with those suppliers to ensure compliance and the highest standards of environmental protection.

through the incentive-based market system to encourage enterprises to take actions. Therefore, green supply chain management is closely related to the green transformation in China.

1.1.1 Green supply chain management is an innovative mechanism to facilitate China's green transformation

According to the "12th Five-Year Plan", which covers a key period in China's overall transformation, economic policies should focus on changing the economic development mode and structure to promote green transformation and green growth.

Green supply chain management can serve as a significant tool to realize China's "green transformation". In the long run, green supply chain management – which takes environmental protection and energy conservation into account during the life cycle of production from design, to resource extraction to manufacturing, marketing and recycling or end-of-life management – will not only reduce environmental impact but also optimize resource allocation in China, making it an innovative system to foster the country's green transformation.

1.1.2 A green supply chain management system is vital to achieve the goals of energy saving and emission reduction set by the state

During the "11th Five-Year Plan" period, China focused on energy conservation and emission reduction as an engine to adjust its economic structure, change its development mode, address climate change and promote scientific advances, and set a target of reducing energy consumption per unit of GDP by 20% and major pollutant emissions by 10%. By 2010, the targets set for "11th Five-Year Plan" had mostly been realized, with national energy consumption per unit of GDP falling by 19.1%, total national emissions of sulfur dioxide reduced by 14.29% and national emissions of chemical oxygen demand reduced by 14.25%.

In the "12th Five-Year Plan", emissions reduction targets have been further upgraded by the Chinese Government. The "Double Ten" (10% reduction of SO_2 and COD) was extended to the "Double Ten and Double Eight", that is, emissions of four major pollutants, Chemical Oxygen Demand (COD), sulfur dioxide, ammonia nitrogen and oxynitride should be reduced by 8%, 8%, 10% and 10% compared to 2010. However, as China's economy continues to grow, it is facing huge pressures in the area of energy conservation and emission reduction. Simply continuing the emission and energy reduction measures instituted under the "11th Five-Year Plan" may lead to huge investment with limited achievements. A system of green supply chain management, which uses market forces to

promote lower lifecycle environmental impacts and energy usage, will provide a new avenue for meeting the ambitious goals of the "12th Five-Year Plan".

1.1.3 A green supply chain management system is necessary to promote "made in China" products going global

As the global financial crisis goes deeper, a growing number of international trade disputes are arising, with trade barriers based on environmental issues being more frequently applied. In general, China's environmental standards are lower than those of developed countries due to the differences of development stage, but the international community tends to mistake the products of "Made in China" as high-carbon and heavy-polluting products. Today, significant changes have taken place in the international market, and China, as a major exporter, is directly or indirectly forced to address environmental issues that could become barriers to international trade. A fully realized green supply chain management program would be beneficial not only for China to reduce environmental impacts and energy consumption domestically, but also to avoid the economic risks arising from green barriers to international trade.

1.1.4 The development of a robust green supply chain program relies on improving governments' and enterprises' green procurement and the public viewpoint on green consumption

With the growing public awareness of environmental protection, consumers in particular are increasingly demanding environmentally-friendly products. Their viewpoint on green consumption and actions to protect the environment will promote the development and production of environmentally-friendly products, with associated benefits in resource saving and environmental protection. Consumers are regarded as the end users, their green consumption patterns will urge Chinese enterprises to implement green supply chain programs and increase their green competitiveness.

Furthermore, the public's increasing recognition of green products will promote a change from the traditional procurement mode to green procurement for governments and enterprises. With huge buying power represented by government and large enterprises, green procurement can quickly promote changes in production throughout the industrial supply chain.

1.2 Research objectives

CCICED has set up this Special Policy Study (SPS) to provide a systematic

examination of green supply chain development and management in the Chinese context. The hope is that through the analysis of international experience as well as research and case studies concerning domestic experience, operable policy recommendations can be identified. It is hoped that the research also can push forward green industry supply chain management by Chinese enterprises, influence China's industrial restructuring, and contribute to sustainable economic development.

The Green Supply Chain SPS focuses on the following elements:

(1) Examining linkages of green supply chain management, green transformation and the driving forces;

(2) Analyzing international green supply chain management experience and its implications for China;

(3) Sorting out the status and issues of the green supply chain management in China's development;

(4) From the perspective of strengthening the operability of implementation policies and environmental assessment, researching the existing government green procurement system and its implementation results;

(5) Identifying and sorting out the corporate case for good practice pertaining to green supply chain management, offering guidance to Chinese enterprises, so as to improve their ability of comprehensive environmental management.

The goal of the SPS is to put forward policy recommendations and operational measures that reinforce domestic policies and measures associated with government procurement, greening supply chain with enterprises, environment and sustainable development.

2. The Concept of Green Supply Chain

2.1 The concept of green supply chain

The complete concept of "green supply chain" (GSC) was first proposed by the Manufacturing Research Consortium (MRC) of Michigan State University in the U.S. in 1996, for comprehensively considering environmental impacts and resources optimization of manufacturing supply chains. That is to say, it aims to minimize the environmental impacts of the products end-of-use by tracking and controlling the raw material procurement, in order to ensure compliance with environmental rules and regulations starting from the stage of product R&D.

There is no existing standard definition for green supply chain, and many definitions

are available. For the purpose of this report, the concept of green supply chain can be put in this way: when considering the impact of its products on the environment, the enterprise should not only take its own processes into account, but also the sourcing of raw materials, the consumption of the products, as well as the recycling of the wastes, i.e., the whole process of the product life cycle (see Figure 1). To ensure enterprises in supply chain comply with the unified environmental requirements is the way to improve their environmental performances and reduce environmental impact so that green and low-carbon development can be realized.

Green supply chains differ from traditional ones in that green supply chain management is integrated into the entire process including planning, procurement, production, consumption, and reverse logistics. The entire supply chain is managed as a green system and every process focuses on environmental management and risk control.

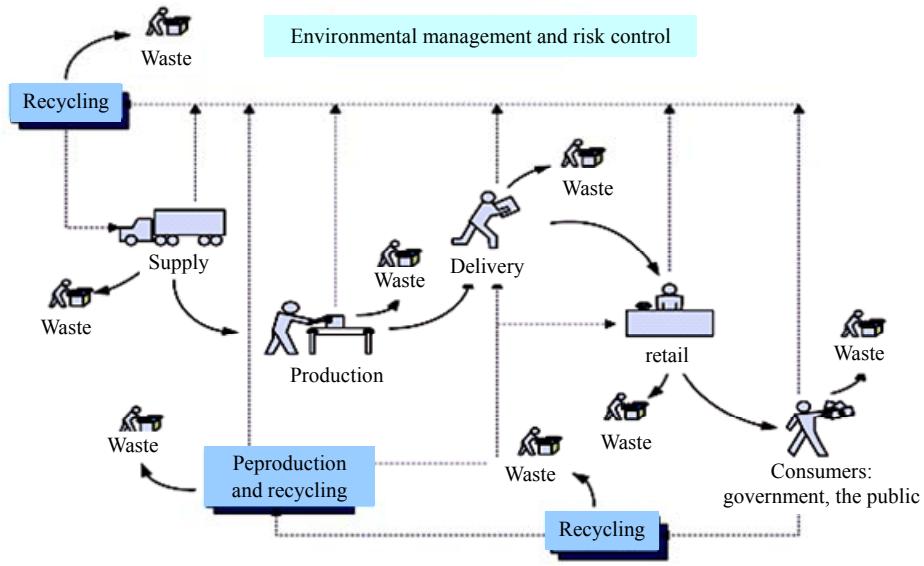

Figure 1 Management system of green supply chain

2.2 Differences between green supply chain and traditional supply chain

The green supply chain focuses on changes in the following five aspects compared to traditional types of supply chain:

(1) The goal. The traditional supply chain aims to lower the cost and improve the efficiency of supply chain enterprise so as to maximize the economic benefits. Green supply chains also seek to maximize economic benefits, to decrease the consumption of

resources and energy and to reduce the emissions of pollutants – all in an effort to create a socially responsible enterprise, and to balance the economic benefits, social effects and environmental effects.

(2) Management structure of supply chain. For green supply chain management, environmental performance is included in the enterprise's internal and external management, which is lacking in traditional supply chains.

(3) Business model. A green supply chain means a more complete business model. Elements including low carbon and environmental protection must be included in the entire logistics and supply chain to realize a complete green and low carbon supply chain system through the whole life cycle, from raw material sourcing and industrial design to production and delivery.

(4) Business process. The traditional supply chain starts with suppliers and ends with users, and the products flow is one-way and irreversible, known as "Cradle- -to-Grave". The green supply chain changes this management mode and hopefully realizes "Cradle-to-Reincarnation". In green supply chain thinking, product flow is circular and reversible and all products must be managed throughout the entire life cycle, and beyond so that "waste" finds a second life or becomes raw material available for new production or other purposes.

(5) Consumption pattern. The consumption pattern of the traditional supply chains is a voluntary initiative governed by consumer interests and business activities. Green supply chains can be promoted through green government procurement, corporate social responsibility, and sustainable consumption education and practices.

3. International experiences of green supply chain

3.1 The United States government and enterprises – sponsor and promoter of green supply chains

The U.S. government has issued vigorous, flexible and scientific laws and regulations to guide policy development of green supply chains. Policies and regulations concerning pollution control, traffic control, food contamination prevention, and interests to safeguard consumers' health have already been issued, and corresponding monitoring systems also have been established.

3.1.1 Market incentives are developed to guide enterprise's environmental behaviors

Taxes and incentives have been set in place by the U.S. government to change the financial decisions of a company and therefore help promote greater efficiency, adoption of

renewable energy or better resource use. Market incentives for reducing aggregate supply chain energy use can also include the implementation of subsidies to support renewable energy initiatives in companies along the supply chain.

3.1.2 Enterprises are required and encouraged to report on supply chain-related environmental impacts by laws and regulations

The U.S. government requires enterprises to disclose information about the environmental impacts of areas of their operations including their supply chain. The Toxics Release Inventory requirement from the EPA, which requires companies to report on their toxic chemical releases, including location, is an example of such a program[①].

In addition, the U.S. government also makes efforts to carry out reporting systems on environmental information. American companies, along with many companies doing business in the United States, are required to report on a wide variety of financial and corporate governance issues. This reporting is highly regulated, takes place regularly, and includes exhaustive amounts of information about the companies and their operations. Most corporate reporting is overseen and published through the Securities and Exchange Commission.

3.1.3 Enterprises are encouraged by the government to launch voluntary programs to reduce the environmental impact of supply chain

The U.S. government has sponsored voluntary programs to encourage enterprises to participate in green supply chain as part of helping them work towards more sustainable operations. The government-sponsored programs are not only guidance-based, but also tend to be collaborative. Voluntary programs can also provide a forum for companies to share best practices, which can have significant cascading benefits in an industry sector. SmartWay program is one of the examples. Initiated by the EPA in 2004, the SmartWay program is a partnership between government and industry that provides logistics for companies with strategies for reducing fuel use through efficiency measures[②].

3.1.4 Promotions on government green procurement

The U.S. government has a complete green procurement system that plays an incentive

① http://www.epa.gov/tri/, E.P.A. (2011 19-April). *TRI Home*. Retrieved 2011 20-April from Toxics Release Inventory Program: http://www.epa.gov/tri/.

② US EPA. (2011 1-April). *Smart Way*. Retrieved 2011 7-April from U.S. Environmental Protection Agency: http://www.epa.gov/smartwaylogistics/.

role in the healthy development of green supply chain. It mainly adopts federal acts and presidential executive orders as the legal basis for promoting green procurement. These acts and orders include: Executive Order No. 12873 *Federal Acquisition, Recycling and Waste Prevention*, No. 13101 *Greening the Government through Waste Prevention, Recycling and Federal Acquisition*, No. 13148, *Greening the Government through Leadership in Environmental Management* presidential executive order, and so on.

3.1.5 Prudence in partnership establishment for a win-win result

Leading American enterprises have many concerns with establishing partnerships with suppliers and often giving priority to environmental performance in their evaluation of suppliers. Final suppliers are selected based on their compliance with environmental laws and regulations as well as the strength of the enterprise's own indicator systems, the data and information provided by suppliers through questionnaires, and the results of quantitative and qualitative analysis. Once the suppliers actually become partners, the leading enterprises won't rely only on monitoring and evaluation, but will establish a win-win partnership with them by providing guidance, support and help. For example, meetings and environmental forums will be held with suppliers, and training will be provided for them.

3.2 EU – expanding global impacts of green supply chains by green products specifications

The EU promotes the spread of green supply chains globally through specification and designation of green products. They hope to take the lead in the environment-friendly development of the manufacturing industry based on the massive business market within the EU and beyond. Major EU measures include those noted below.

3.2.1 Environmental laws promoting a green supply chain revolution

EU approved Waste Electrical and Electronic Equipment (WEEE) and Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS) specifications have far-reaching influence on the electrical appliance manufacturers worldwide; and, as well, on the entire electronics industry supply chain consisting of electric items manufacturers, distributers, as well as contractors. Electric appliance manufacturers seeking market share in the EU have to on the one hand sustain higher costs arising from "green barriers", and on the other hand, advance their production technologies which include the extension of product life, the reduction of high energy-consuming products, the application of friendly-assembly and easy-disassembly design, the alternatives of hazardous substances and the continuous greening of production line. In this sense, the WEEE and

RoHS help to establish green supply chains throughout the global electronic industry and to provide experience in electronics waste management for other countries in various parts of the world.

3.2.2 Eco-labels

As early as 1992 the European Ecolabel① was launched as a voluntary scheme to encourage the private sector in its development and marketing of environmentally friendly products and services. Products and services that have earned the label carry a simple flower logo, which allows for easy recognition across the 27 member states (plus Norway, Iceland and Liechtenstein).

3.2.3 Green Public Procurement (GPP)

Central to the EU's policies is Green Public Procurement, seen both as a spur and model for the private sector to emulate, and a significant weight in its own right as a portion of GDP. Europe-wide, public authorities account for approximately €2 trillion, or 17% of EU GDP, and constitute therefore a major lever in shifting markets towards sustainable development. GPP provides an incentive for industries to develop green technologies and products and represents sufficient volume to help industries reach critical mass for making the sustainable production of goods and services viable.

4. Status Quo and Challenges of Green Supply Chain in China

4.1 Status quo of green supply chain development in China

The Chinese Government and businesses lag behind in understanding the concept of green supply chain. As a result, green development of the entire supply chain has started late by comparison to some other countries, and the theoretic studies and practices are still in the infancy. In light of the high consistency between green supply chain and green transformation in terms of the target and actions, green supply chain could evolve to be a vital environmental and economic tool at the micro level to achieve the green development and green transformation.

The Government increasingly has recognized the importance of green supply chain development, and therefore has continuously sought to create a favorable environment for market-based approaches through laws, policies and other means. Meanwhile, some

① http://ec.europa.eu/environment/ecolabel/about_ecolabel/what_is_ecolabel_en.htm.

domestic multinationals and large enterprises in China also have realized the strategic role of environment and resources in building competitive advantage during their operation and management, and therefore have initiated preliminary exploration of green supply chains. Some suppliers with long-term perspectives and capabilities have begun to break the barriers to green exports and embarked on the green supply chain development.

Government, business, the market and the public shoulder different responsibilities in green supply chain development, as shown in Figure 2.

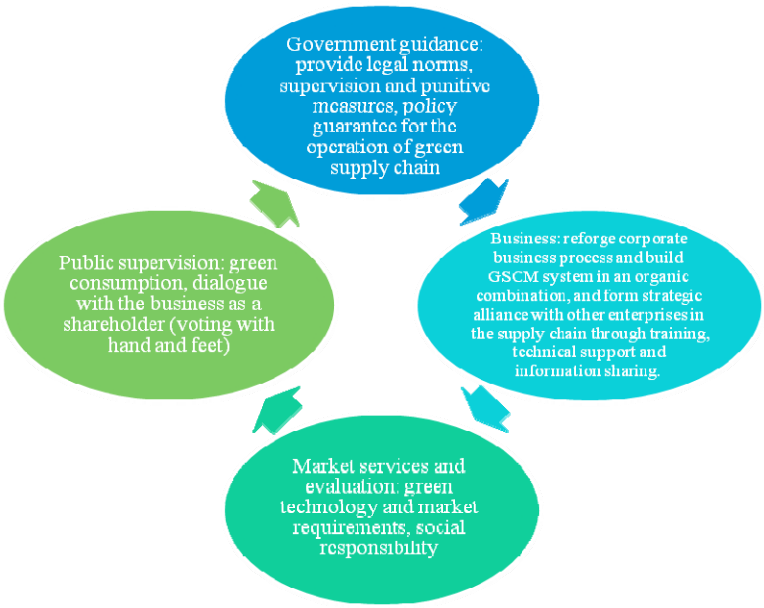

Figure 2 Relations among government, business, the market and the public

4.1.1 Government guidance on green supply chain

(1) Government as the regulator in the initial stage of green supply chain development

The legal institutional framework for environment and resource protection has been in place in China and progressively improved after years of efforts, such as energy saving system, environmental standards, environmental monitoring and reporting system, environmental resource planning system, target responsibility system for environmental protection, quantitative examination system for comprehensive urban environmental improvement, environmental impact assessment system, the “three simultaneous” system (design, implementation and production), sewage discharge declaration and registration system, natural resources ownership system, the permit system in the field of environmental

resources, paid use of natural resources, and the charging system for sewage discharge. Chinese laws and other guidance concerning green supply chains and their significance are listed below.

Law on Energy Conservation

Law on Renewable Energy

Law on Promotion of Cleaner Production

Law on the Prevention and Control of Environmental Pollution by Solid Wastes

Law on Environmental Impact Assessment

Law on Circular Economy Promotion

Directory of Listed Companies Subjective to Environmental Inspection by Sector

Opinions on the Implementation of Environmental Policies and Regulations to Prevent Credit Risk

Guideline for the Preparation of Corporate Environmental Reports

(2) Promote macro-policy environment conducive to green supply chain development

During the "11th Five-Year Plan" period, China has for the first time set the reduction of energy consumption intensity and major pollutant emissions as the binding target of economic and social development, and carried out a series of actions in the hope of energy-saving technological progress, such as shutting down small high-polluting and energy-consuming enterprises. As of 2010, energy consumption per unit of GDP, as well as sulfur dioxide (SO_2) and chemical oxygen demand (COD) emissions have decreased by 19.1%, 14.29% and 12.45% respectively. Not only has the binding target provided in the *Outline of the Eleventh Five-Year Plan* been accomplished, but also the obvious rising trend of energy consumption per unit of GDP and major pollutant emissions has been reversed.

Energy saving and emission reduction seems even more arduous in the "12th Five-Year Plan" period. In terms of energy saving, by 2015, energy consumption per 10,000 *Yuan* of GDP shall be declined by 16% over the 2010 level. In terms of emission reduction, COD and SO_2 emissions nationwide shall not exceed 23.476 and 20.864 million metric tons respectively, a drop of 8% compared with the 2010 levels; national ammonia and nitrogen oxides emissions shall be limited within 2.38 and 20.462 million metric tons respectively, 10% down 2010 levels.

Although the emission reduction target during the "12th Five-Year Plan" period is slightly lower than that in the previous period, it is not easy to make it happen, and the pressure is even greater because the marginal effect gradually diminishes with the decline of the baseline of emission reduction. In light of the mandatory targets, emission reductions should be deemed as sourced not only from projects, structure and management, but also should incorporate

voluntary market emission reduction arising from green supply chain actions.

(3) Government green procurement – interpreting government's role as a green supply chain program promoter

Government green procurement as an important instrument to promote green supply chain has attracted increasing attention from the Chinese Government. Its main legal basis includes:

1) Law on Cleaner Production Promotion (2002) specifies that Government at all levels should give priority to energy-saving products, water saving products, products with waste recycling, and other products beneficial to environmental and resource protection in the procurement.

2) Law on Government Procurement (2003) specifies that Government procurement should contribute to the objectives of national economic and social policy, including protecting the environment.

3) Law on Prevention and Control of Environmental Pollution by Solid Wastes (2004) encourages units and individuals to purchase and use recycled products and reusable products.

4) Law on Promotion of Circular Economy specifies that government procurement policy should be conducive to the development of circular economy and give priority to energy saving, water saving, materials saving products, products conducive to environmental protection and renewable products.

The State Council issued the *Decisions on Implementing the Scientific Outlook on Development and Enhancing Environmental Protection* in 2005 and further stressed the need to establish a government green procurement system①. In the same year, it released *Opinions on Accelerating the Development of Circular Economy* to clarify the policy orientation for government agencies to implement green procurement②.

In order to implement the documents issued by the CPC Central Committee and State Council, Ministry of Finance (MOF) and MEP jointly issued the *Implementation Opinions on Government Procurement of Environmental Labeling of Products* and publicized the first batch of 14 categories of environmental labeling products for government procurement in

① The document stipulates "vigorously develop the circular economy...in the consumer sector, greatly advocate environmentally friendly consumption patterns, implement environmental labeling, environmental certification and government green procurement system, and improve the renewable resource recycling system."

② The document calls for "vigorously advocate consumption patterns conducive to environmental protection and resource conservation, encourage the use of energy-efficiency labeling products, energy-saving and water-saving certified products, as well as environmental labeling products, food with green label and organic label, reduce excessive packaging and the use of disposable supplies. Government agencies implement green procurement."

October 2006. It shows that environmental criteria have been formally incorporated into the Chinese government procurement model. The document requires "state organs, public institutions and organizations at all levels shall give priority to environmental labeling products in the procurement with financial fund and not purchase products harmful to the environment and human health." Such a system is an important breakthrough in China's government procurement policy and system and marks the official kickoff of Chinese government green procurement.

In the years of government green procurement implementation, MOF and MEP have jointly announced 8 batches of the lists of environmental labeling products for government procurement, expanding the product scope from the original 14 categories to the current 24, enterprises from 81 to 550, and product models from 800 to over 18,000. These products include IT equipment, such as automobiles, personal computers, copiers and printers, building materials, such as paint, furniture and plates, and also solar products, as shown in Figure 3.

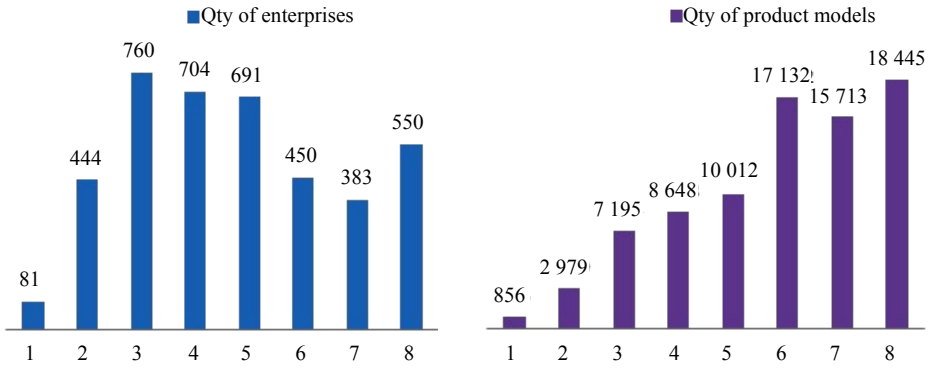

Figure 3 Numbers of enterprises and product types in the lists of Chinese government green procurement

Government procurement of environmental labeling products has played an active role in guiding and promoting green production and consumption and building a resource-saving and environmentally-friendly society, and won strong support and popularity among the various manufacturers of green products. Data show that in 2009, the national procurement of green products was valued at 14.49 billion *Yuan*, accounting for 74% of the government procurement of products in the same category, while the number of government green procurement amounted to 272.6 billion *Yuan* during the "11th Five-Year Plan" period, accounting for about 65% of the government procurement of products in the same category.

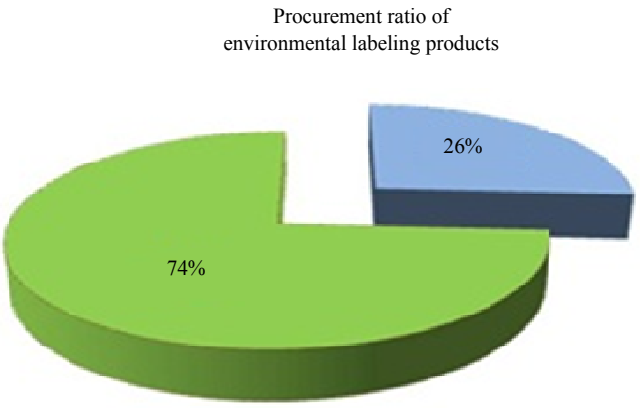

Figure 4 Government procurement ratios of green products in 2009

Government green procurement was officially incorporated into the "12th Five-Year Plan" in 2011, making an innovative move in the new era of environmental protection. Its implementation positively advances the building of a resource saving and environmentally friendly society and thus enjoys great support and welcome from the majority of manufacturers of green products, and moreover, guides sustainable consumption in the whole society.

(4) Green trade transformation supports green supply chain development in China

International trade and green supply chains are closely connected. International trade not only promotes the transnational spread of green supply chains, but also drives the sustainable trade. In consideration of China's actual situation, there are three main influencing factors.

Firstly, China frequently encounters friction in its international trade. China may have more acute confrontations with trading partners with as its share of products in the international market increases. For purposes including environmental protection and trade protectionism, other countries engaged in international competition sometimes have used environmental standards higher than those of China as a means to restrict the exports of Chinese products. With movement up the value chain of China's export structure, direct competition with the developed countries will become more intense, which will require raising the environmental requirements on China's exports.

Secondly, the issue of climate change has brought new challenges to China's economic and trade development. Border tariff measures developed countries might take, such as carbon tariffs, would directly affect China's export competitiveness. The Chinese

Government has to develop response measures to strengthen green supply chain and thereby help improve the international competitiveness of Chinese enterprises.

Thirdly, building a green supply chain network should serve not only as a measure in response to green trade barriers, but also as a barrier to resist contaminated products entering from developed countries, and to stimulate development of domestic market standards. Developed countries should conform to such green market standards when exporting products or investing in China and setting up factories, otherwise, the products should not be allowed to enter any link in the supply chain. Such market constraints sometimes are more effective than policy constraints.

The Chinese Government has already implemented a series of "green trade policies" and thus has played a positive role in promoting green supply chain development in China, mainly reflected in the development of environmental certification standards in accordance with international standards and the imposition of export tariffs on high-polluting industries.

4.1.2 Corporate green supply chain practices

(1) Multinationals play a promoting role in the initial development of green supply chain in China

Multinationals play a positive role in guiding the implementation of the green supply chain system in China. To meet the parent company's requirements or respond to the needs of business globalization, such companies take the lead in green supply chain practice in China and gradually extend it to the upstream suppliers. A number of foreign invested enterprises or joint ventures have put requirements on the GSCM of suppliers, such as IBM, Dell, HP, Sharp, Sony, Samsung, Motorola, Ricoh, Shanghai GM and Wal-Mart.

At present, most multinationals implementing green supply chain in China raise requirements on suppliers' environmental compliance. For example, suppliers are required to pass the certification of ISO14001 environmental management system. According to the characteristics of their own products, as well as product-related requirements in international laws and regulations, some manufacturers also put forward requirements on the hazardous substances in raw materials and components, design and recycling. In general, different types of enterprises have different priorities in green supply chain implementation. For example, manufacturing enterprises pay more attention to green design, green supply, green production, etc., while retail enterprises are more likely to consider green logistics and green supply.

It can be said that, green supply chains cannot take root and sprout in China without the contribution of excellent multinationals. Such enterprises promote green transformation in

accordance with the actual situation in China in the initial phase of supply chain development.

(2) The practices of China-invested companies

In the face of rising green consumption trends, increasing numbers of domestic enterprises in China are beginning to attach importance to green competitiveness. In terms of the implementation of green supply chains, domestic enterprises are evidently polarized in their performance. On the one hand, large and medium-sized enterprises, especially state-owned enterprises, promote green supply chain practices in China, whether actively or passively. However, the other pole is represented by many SMEs, which often are unable to carry out professional transformation, or technology R&D. Due to their thin profit margins and limited financial resources, it is impossible for them to implement green supply chains. This reflects the reality of China's industrial development at present.

4.1.3 China's green consumer market and green supply chain management development

The observation that "China has limited capacity of green consumption and the Chinese consumers do not know green products" forms the biggest misunderstanding of the Chinese market. TüV SÜD Asia Pacific Limited conducted a green market research initiative in China, India and Singapore in 2010. The company compared the attitude towards green products, services, policies and certification of consumers and businesses. Several sectors (appliances, food and beverage, footwear and apparel) were examined. Its official survey report released in January 2011 shows that, compared with India and Singapore, China has paid the most attention to and demand of "green" products.

94% of the Chinese urban consumers surveyed are willing to pay high additional costs for clearly proven "green" products and services; 45% more than that for non-green goods on average. However, only 60% of the Chinese companies think that consumers would like to spend more for "green" certification, and expect them to pay at most only 13% more. In the survey, 59% of the enterprises in the three major sectors have already produced or traded "green" products, but they still fail to properly assess the urgency of such demand among urban consumers. Most companies have not yet formulated or explicitly expressed the formulation of appropriate rules or guidelines to minimize the environmental impact.

To sum up, the green consumer market has taken its initial shape in China, with tremendous progress in market consumer desire and spending power. The green consumer market has become the basis for green supply chain development. Traditional supply chains have had difficulties in meeting "the desire for green" in the consumer market. Many

Chinese enterprises have not yet realized the point, and squander away opportunities by comparison with transnational corporations.

4.1.4 Enhanced public environmental awareness pushes ahead green supply chain development in China

The consumer is the ultimate driver determining whether green products thrive or not, and to what extent. Increasing public attention to environmental issues will press the government and industry to improve green standards and norms. After a series of environmental and human health hazard events, such as "heavy metal pollution, soil pollution, water pollution", the public environmental awareness of the Chinese consumers has been significantly enhanced.

According to the TüV SÜD Asia Pacific Ltd. survey, about 50% of urban consumers think action should start at the level of individual green consumption but rely on the collective public power for a final solution, while 75% of the businesses said the government should introduce explicit initiatives to promote sustainable development and corporate social responsibility. The majority of businesses pointed out that industrial and government regulations are the main reasons behind their enforcement of social responsibility and sustainable development criteria.

As the mainstay of the market and the endpoint and target of industrial supply chains, the consumer determines the "survival" of the market and individual businesses. With the awakening of consumers' green consumption awareness, GSCM has been endowed with the fertile soil for rapid development.

5. Main conclusions and policy recommendations

Greening supply chains is important for China's green transformation. Although there are some beneficial conditions in place for developing green supply chain development in China, the lack of government policies, absence of industrial guidance and corporate strategy on green supply chain, the situation of an immature market of green consumption and public awareness, and long-way-to-go green trade transformation greatly challenges the development of green supply chains in China. Below are the main conclusions arising from the study and key policy recommendations.

5.1 Main conclusions

(1) Pressure from the international market and monitoring of domestic environment pressures will support Chinese enterprises to participate in green supply chain management.

As China is facing growing pressures from its economic transformation and international trade, the establishment of a green supply chain program would be consistent with the goals of green economic development and sustainable development of China's economy in the future.

(2) Though China's green supply chain is in an initial stage, the policy and market will provide support for its establishment. Most of China's laws and regulations on environment and resources overlap with those concerning green supply chain, and governments have the ability to play roles as regulator, driver and monitor. Meanwhile, as green consumption patterns grow, they will also provide support for the establishment of green supply chain.

(3) Practices of green supply chain for enterprises tend to be spontaneous and voluntary in light of the lack of guidance by laws and regulations and policies. Though China has no specific laws and regulations and policies relevant to green supply chain, both transnational enterprises and leading Chinese enterprises have a strong interest in China's green supply chain implementation. At present, some transnational enterprises have introduced green supply chain concepts to China while Chinese state-owned enterprises and private sectors are likely to participate in this initiative. However, these are individual instances, and pollution and resource over-use are still occurring in practice due to the inconsistent application and environment of environmental standards.

(4) The government, enterprise, the market and the public all interact with one another in an integrated green supply chain program.

The government can develop policies and programs that mandate and reward green supply chain management; enterprises will carry out the green supply chain management practices; market forces will monitor implementation of green supply chain by bringing more business and reputational benefits to those enterprises that participate, and the general public will reinforce green supply chain success through consumer loyalty to those enterprises and products that reflect green supply chain management.

5.2 Policy recommendations

China's green supply chain has just been initiated. The government and enterprises are gradually accepting the idea that enterprises should be guided by "Green" concept systems in an integrated way so as to achieve a green transformation of the market. Green supply chain, which serves as a tool to address environmental problems through a market mechanism, will not only complement and complete China's current environmental management system, but also effectively intensify environmental management by enterprises.

5.2.1 The guiding and regulating role of government should be emphasized to establish and complete China's laws and regulations and standards concerning green supply chain

The full implementation of green supply chain requires the government's decision-making; only when the government's policies for encouragement, coordination and investment are matched can green supply chain be promoted.

(1) The government should play a leading role in the green supply chain system, and develop *Green Supply Chain Management Regulation* and *Industry Evaluation Standard on Green Supply Chain*. It also should develop its green supply chain certification in combination with the existing environmental certification system.

It is recommended that the Ministry of Environmental Protection should take the leading role, while Ministry of Finance, Ministry of Commerce, National Development and Reform Commission, China Banking Regulatory Commission, China Securitas Regulatory Commission and other government departments offer collaboration. In this way, a *Policy Guideline for Green supply chains in China* should be introduced, helping enterprises realize the goals of sustainable operation and green supply chain starting from complying with regulations, reducing commissions to carrying out low-carbon and green development. Additionally, in adapting to the policy guideline, *Industry Standards and Procedures for Green supply chains* for different industries should be developed. Meanwhile, combining with the existing environmental certification system, green supply chain certification also should be developed so as to ensure the green supply chain can be standardized, operational, monitored, legitimate, and evidence-based.

The government should adopt product stewardship programs for key consumer and industrial products. These programs should be designed to minimize the end-of-life impacts of key products and to encourage reuse and recycling by requiring manufacturers to take back, recycle or properly dispose of those products. Product categories to be addressed in the stewardship programs should include: consumer electronics, batteries, paint, tires, carpet, mercury-containing products (like thermostats and fluorescent lights), bottles and Cans.

The programs would be designed to share responsibility among government, manufacturers and consumers of products as follows:

1) Government will establish goals and timelines for recovery and recycling of each product category, and will launch programs to educate consumers and manufacturers on the aims and requirements of the stewardship programs.

2) Manufacturers will be individually responsible for meeting their market share of

specified recovery and recycling goals, but will be allowed flexibility for how the goals are met. For example, manufacturers may join a collective system for managing end-of-life products, or may establish a third party organization to meet the program requirements.

3) Consumers will participate by bringing appropriate products to designated collections sites at their end of life. Consumers will not be expected to pay for product collection (although compliance costs can be passed along through product pricing).

Each product stewardship program would have enforcement provisions that allow for daily monetary penalties should any manufacturer not have a plan in place to meet program goals within a set period after program commencement, and should any manufacturer not meet the performance goals and timeline outlined in their own compliance plan.

The government should consider adopting a joint Extended Producer Liability law under which all links in the supply chain could be considered liable for violations of environmental and health laws, contamination or misuse of property, or damages to health and public resources. Consistent with Chinese practices for environmental enforcement and for civil liability, an Extended Producer Liability law would extend responsibility to all of the following:

1) The current owner or operator of the facility immediately responsible for the violation or damage;

2) The owner or operator of the facility at the time the violation occurred or the damage was first initiated; and the purchaser of the products or services whose production contributed to the violation or damage incurred.

(2) The economic policy should be combined with green supply chain, thus effectively changing the market behaviors of suppliers from market-oriented to green-based.

1) Provide enterprise participating in green supply chain with favorable taxation measures and green loan support. Support the green supply chain market through guidance of economic means. Through the introduction of green tax incentives, green subsidies and other policies, the enterprises should be guided with regards to production and operation, and be encouraged to improve efficiency and increase investment in environmental improvement, thereby contributing to the sustainable development of the supply chain.

2) Establish voluntary projects of green supply chain to encourage enterprises to participate in such projects. The government can sign voluntary agreements of green supply chain with enterprises, and effectively realize the implementation of green supply chain.

3) Require listed enterprises to disclose information about the environmental impacts from all aspects of their supply chain operations through verification measures on listed

enterprises. The government should develop a list of the most harmful toxic substances and require enterprises to report publicly on their annual emissions of those substances. Enterprises should be encouraged to publish, on a regular basis, sustainability development reports and corporate social responsibility reports for the production chain.

4) Carry out demonstration projects by building green supply chain system in Eco-industrial zone. At present, the construction of China's Eco-industrial zone coincides with green supply chain, thus it can be the location for demonstration practice.

5) Improve performance standards and industry technical standards to meet international level. Enterprises should be encouraged to promote technological innovation, stimulate green transformation, and gradually establish performance standards and industry technical standards. In this way, the green supply chain in enterprises can be strengthened to provide support for the successful completion of emissions reduction targets during the "12th Five-Year Plan".

(3) The government should play leading and exemplary roles, and intensify green public procurement policies.

Government should focus on the integration of green public procurement plan with the existing procurement policy, consider how to reduce the environmental impact of supply chains and reduce procurement costs. Specifically, the government can carry out green procurement policy through the following aspects, so as to enhance the effectiveness and impact of green supply chain in China:

1) Complete *Government Procurement Law* that requires all central and provincial procurement officials to assess and give preference to those products and services that are environmentally preferable.

2) Through the platform of government public procurement and giving priority to labeling product standard, the green product procurement indicators should be implemented and general principles and guidelines for government green procurement should be developed. On the platform of government public procurement and by the way of certification, green product procurement indicators should be set, so as to compulsorily promote enterprises entering into the public procurement platform to adopt green supply chain. Industries and products exerting significant impacts on environment should take the lead in indicators and compulsory government procurement so as to give full play to the government procurement measures and enable the government procurement to play an important role in pollutants emission reduction, environment monitoring and green economic development.

3) Develop *General Principles on Government Green Procurement*, which should

integrate government green procurement requirements and enterprises carrying green supply chain requirement, and specific requirements on initiators, management, procurement standard, evaluation and monitoring, and performance report. Green procurement guidelines should require that government goods and services are procured only from enterprises able to demonstrate current and consistent compliance with all relevant central and provincial environmental rules and guidelines, including policies and regulations to promote clean production, circular economy, and environmental labeling.

4) Establish standard database of government green procurement to provide a platform for information exchange on green products, offering green products information and technical services for suppliers, manufacturers, purchasers, and consumers.

(4) Green trade should be promoted with the supply of public services and research on performance evaluation of green trade.

The existing public service platform for foreign trade should be supplemented with contents of green trade, introducing the technical standards, laws and policies of major countries with regards to environmental protection and low-carbon development, and advanced experience of advanced green trade enterprises. The platform can also provide enterprises with technical training and management personnel for green trade.

In order to enhance the transparency of green trade, and make an objective evaluation on the economic and social benefits of green trade policies, a green trade policy performance evaluation system should be gradually established: to monitor the carbon dioxide emissions of import and export of goods in the whole process of production, from raw materials, manufacturing, contracting, transportation, storage, marketing, to waste recycling; to evaluate the positive results of enterprises which have adopted low-carbon technologies and management practices; and to assess the performance of China's government policies for trade green.

(5) Pilots should be considered to promoted green supply chain nation-wide.

One effective way to promote green supply chain management system is to conduct pilots in certain regions first and then extend to the whole nation. The pilots should include the policy innovation and strengthened supervision from the government, activated market forces of certification and other public services, educating consumers for green consumption and so on. With regard to the locations for conducting the pilots, regions like Tianjin Binhai New Area, Yangtze River Delta and Pearl River Delta with sound economic infrastructure and motivations for green transformation are recommended.

5.2.2 Practice in enterprises should be promoted to establish China's economic system of green supply chain

(1) Through the model effect of green supply chain, "Star Enterprises for Green Supply Chain in China" should be cultivated, which can drive the overall development of green supply chain.

Further enthusiasm of enterprises for environmental protection can be created through honorary recognition awards, publicity and other forms, and enable enterprises to realize that the development of green supply chain can improve their core competitiveness. "Star Enterprises for Green Supply Chain in China" can be fostered through competition and industry consolidation, and these star enterprises can gain further market acceptance and public awareness through the "Green supply chain Certification System in China".

(2) A "Green Supply Chain Network Platform" should be constructed to strengthen the cooperation among industries, enterprises, government, NGOs and other external institutions.

Through the establishment of "Green supply chain Network Platform", Chinese enterprises on the green supply chain can further expand market reach, play the active role of the network platform, integrate market resources, promote the integration of upstream and downstream enterprises on green supply chain, and play the role of intensification and integration of the platform.

Establish standard database of government green procurement to provide a platform for information exchange on green products, offering green products information and technical services for suppliers, manufacturers, purchasers, and consumers.

(3) Green supply chain pilot programs should be carried out within enterprises to verify regulations and policies in practice. Green supply chain pilot programs are suggested among enterprises and follow MRV (measure, reportable and verifiable) principles. A third party is responsible for evaluating the initiatives in green supply chain.

5.2.3 Market forces should be activated to reinforce the service and regulation of the market

(1) Industry associations should take the lead to establish a "Promotion Center for Green supply chain", and undertake the functions of regulation for the Fund, green certification, and advocacy organizations.

Cooperation among enterprises, governments, non-governmental organizations and industry should be promoted by giving full play to the functions of Promotion Center for

Green supply chain. Such organizations can be firstly started in areas and locations with green supply chain basis like Tianjin Binhai New Area, Yangtze Delta and Pearl River Delta, so as to intensify the sustainable promotion of green supply chain.

(2) A Fund for the Development of Green supply chain by Enterprises should be set up in combination with Promotion Center for Green supply chain to provide economic incentives for enterprises carrying out green supply chain measures.

It is proposed that the government should take the lead to establish foundation for the development of Green supply chain, whose funding should come from government, enterprises, and social institutions. The foundation can fully mobilize the enthusiasm of enterprises, especially SMEs, which can be encouraged to use more advanced environmental technologies and environmental management concepts, so as to promote a more comprehensive and balanced development for green supply chain in China.

5.2.4 Engagement of the public should be emphasized to create an enabling environment for China's green supply chain

Consumer demand for responsibly produced products can provide a strong market incentive for enterprises to move toward green supply chain management, as can consumer anger toward those enterprises it believes have not acted responsibly.

(1) The concept of green supply chain should be continuously promoted, thus increasing public awareness.

Through the competition and recognition awards of "Star Enterprises for Green Supply Chain", propaganda of green government procurement, green consumption into the community, and other social activities, the importance and urgency of environmental protection should be promoted in the whole society to awaken green philosophy and green consumption awareness among social organizations, so as to create a favorable public opinion and social environment for the implementation of green supply chain, to develop public awareness of green supply chain, and to foster "green consumption thinking" among the Chinese population.

(2) The public should be aware of the environmental performance of local enterprises.

Emissions reports, compliance records and information on specific enterprise and government procurement performance relative to GSCM policies and guidelines should be made easily accessible to the public through online publishing or local dissemination. Through educational programs and community outreach, the public should be encouraged to review enterprise emissions data and CSR reports, as well as local government green procurement performance, and to engage local enterprise managers and government officials

in improving GSCM practices.

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