Green Supply Chain Management in the UK and China construction industry

By

Xiao Xiao

Thesis presented in past-fulfilment of the degree of Master of Science in accordance with the regulations of the University of East Anglia

School of Environmental Sciences
University of East Anglia
University Plain
Norwich
NR4 7TJ

August 2006

© 2006 Xiao Xiao

This copy of the dissertation has been supplied on condition that anyone who consults it is understood to recognize that its copyright rests with the author and that no quotation from the dissertation, nor any information derived there from, may be published without the author's prior written consent. Moreover, it is supplied on the understanding that it represents an internal University document and that neither the University nor the author are responsible for the factual or interpretative correctness of the dissertation.
Abstract

The issue of green supply chain management has received attention in recent years among manufacturing practice and research. With significant environmental impacts, the construction industry needs environmental management tools to address these problems. This research was based on a literature review of the environmental implication of construction industry and green supply chain management. An investigation in the UK and China construction companies were conducted to find out the general view of green supply chain management in the two countries. Initiatives were developed to enhance the awareness of green supply chain management. In addition, the problems encountered in the research were evaluated and possible outlets for future research is suggested.
Acknowledgement

I would like to thank Alan Bond for his guidance and comments on my dissertation. Thanks also to all my tutors, especially Tracey Nitz for giving inspirations and advices during the whole year.

Thanks all the companies who took time to complete the questionnaire.

感谢父母和亲朋一贯以来给我的支持和鼓励！
Chapter 1 Introduction to the research and
literature review

1.1 Introduction

As one of the most important issues to business, environmental management is becoming a key strategic issue for organizational performance (Zhu and Sarkis, 2006). With the introduction of Environmental Management System (EMS) into the business, a corresponding rise in the use of environmental management tools have emerged (O’Laoire et al., 1998). Besides of ‘in-house’ environmental improvement, there is a trend that organizations are extending the parameters of the EMS’s outside the factory and into their supply chain networks (Foster et al., 2001). Environmental impacts occur across all stages of a product’s life cycle, from the raw material extraction, to manufacturing, use and reuse, final cycling, or disposal, namely from cradle to grave (Zhu and Sarkis, 2006). Green supply chain management (GSCM), as well as other related principles, has become an important strategy for companies to achieve profit and market advantages by reducing the environmental risks and improving the efficiency (Sarkis, 1995).

The construction industry is one of the most important sectors for the human civilization by improving society’s physical environment: its output is used for production, commerce and shelter, and for providing vital utilities (Moavenzadeh, 1994). However, construction usually has a significant and irreversible impact on the environment. Impacts including massive use of natural resources, pollution of environment, and high energy consumption are among the whole supply chain from production of construction materials to the end user (CIEC, 1992). With the increasing of environmental awareness, the term of ‘sustainable construction’ is becoming popular. According to Wyatt
(1994), the sustainable construction should include ‘cradle to grave’ appraisal, not only the serviceability of a building during its lifetime, but also the recycling of resources to reduce waste stream associated with demolition should be concerned.

The material purchasing in construction industry is the vital process of supply chain management (Muya et al., 1999). According to Ofori (2000), the increasing environmental consciousness and commitment of businesses, governments, and individuals has inspired the development of procurement and purchasing policies incorporated with environmental requirements. According to Hamner and del Rosario (1998), a set of green purchasing strategy has been developed with four principle attributes. At the same time, companies have found that implementing green supply chain management results in not only environmental benefits, but can also enhance quality of product, raise productivity, and reduce of risk of supply chain interruption or damage to reputation (Lippmann, 1999). However, according to Ballou et al. (2000), the realization of the benefits is hard even if the benefits of such an approach may be easy to identify.

1.2 Objectives

With the background information, the primary objective of this dissertation is to find out the situation of green supply chain management in the UK and China construction industry companies for the potential improvement of sustainable development. The specific objectives are as follows:

1. Assess the environmental implication of construction materials in construction industry
2. Investigate the response to green supply chain management of the UK and China construction companies and find out the similar and different
characters

3. Using the 'green purchasing strategy' to evaluate the situation of green supply management implementation in the construction companies from the two countries

4. Suggest initiatives for the green purchasing and possible outlets for future study.

1.3 Overview of construction industry

The construction industry can be realized as just on-site construction activity or, broadly, as covering the extraction of materials, sales and manufacture of construction products (Envirowise, 2005). The size of the UK construction industry is illustrated by the following statistics:

- Construction contributes 5-10% of UK gross domestic product (depending on the definition of the industry).
- There are up to 355,000 companies involved in construction
- Contractors alone have a gross annual output of around £70 billion.
- Around 1.5 million people are employed on-site.

Figure 1.1 Number of construction and construction-related companies in the UK
The Construction industry plays an important role in shaping society’s physical environment: its output is used for production, commerce and shelter, and for providing vital utilities (Moavenzadeh, 1994). However, construction usually has a significant and irreversible impact on the environment (CIEC, 1992):

- Use of land in competition with other activities, such as agriculture;
- Use of virgin land such as forests, wetlands and coastal areas, which often implies loss of biodiversity;
- Massive use of natural resources, many of which are non-renewable;
- Pollution of air during the transportation of materials and site activity;
- Consumption of water and pollution of water reserves;
- Generation of waste owing to poor resource management;
- High energy consumption on site and in completed facilities; and
- Generation of noise by site activity.

According to Levin (1997), buildings significantly influence the environment in the eight major stress categories: use of raw materials (30%), energy (42%), water (25%), land (12%) and pollution emission such as atmospheric emissions (40%), water effluents (20%), production of solid waste (25%) and other releases (13%).

1.4 Materials in construction

This part involves some information of the use of materials in the construction industry. It relates to the environmental impacts of construction materials to the total human activities. In the Construction Materials Report (Lazarus, 2003), it is calculated that 420 million tones of materials are used in the construction industry in the UK each year, which equates to 7 tonnes per person. Meanwhile, the total consumption of all materials in the UK are about 678 million tones or 11.3 tonnes per person, it means that the construction sector
accounts for over half of the resource use in the UK by weight.

Aggregates are mineral materials, such as sand or gravel, which are used in making concrete. Aggregates make up over 50% of construction materials by weight (240 million tonnes/year) in the UK. Virgin aggregates are a finite resource. Extraction of aggregates results in loss of land, disturbance to neighbours, ecological damage both on land and in water courses and effects the landscape (Lazarus, 2003). It is government policy to discourage by taxation the use of virgin aggregates in order to conserve natural resources. An aggregate levy is to be paid on all natural aggregates to the sites. The new aggregates tax which commenced from 1 April 2002 has incentivised the use of recycled products by adding £1.60/tonne to virgin aggregates (ENDS, 2005).

According to Living Planet Report 2004, tropical forest cover decreased by about 7% from 1990 to 2000, while temperate forest cover increased by about 1% (WWF, 2005). There are two reasons for this deforestation, one is logging for timber, and the other one is the clearance for agriculture. Consequently, two critical implications of deforestation have been emerging. One is the loss of biodiversity in the world, the loss of habitats and species forever. The other is a reduction in the earth’s capacity to absorb CO₂. This drop of absorption capacity is proving critical at a time of increased CO₂ emissions, leading to global warming and worldwide climatic change (Lazarus, 2003). Although timber is theoretically a renewable resource and substitution of wood for other materials in some countries can reduce materials related CO₂ emissions, it can only be considered as such if it comes from sustainable managed woodland. The use of certified sustainable timber is a very positive mechanism for acquiring sustainability of timber usage in the construction industry. The highest accreditation for timber is the internationally certified scheme by the Forest Stewardship Council (FSC).
Cement is one of the basic construction materials, which consists of alumina, silica, lime and other substances. The preparation of cement includes mining; crushing, and grinding of raw materials (principally limestone and clay; calcination of the materials in a rotary kiln; cooling the resulting clinker; mixing the clinker with gypsum; and milling, storing and bagging the finished cement. The process of cement production is energy-intensive (Environmental information centre, 2003). Cement production is the third ranking producer of CO₂ in the world after transport and energy generation, it is responsible for 7-10% of the world’s total CO₂ emission (Greenspec, 2004)

Figure 1.2 Consumption and production of cement in the UK

China dominates more than 1/3 of the total cement production of the world, with an annual production of 863 million tones in 2004 (Digital Cement, 2004). The air pollution from cement industry in China is serious. In China, it is estimated that more than 10 million tonnes of cement dust (about 8 kg/person) were generated in 2000 (China Cement, 2006).
Concrete is a mixture of sand, gravel, crushed rock or other aggregates held together by a hardened paste of cement and water. The process of producing concrete at a ready-mixed batching plant involves accurately weighing the required quantity of each constituent material and mixing them together either in the drum of a mixer truck or in a static pan mixer. During the manufacture of ready-mixed concrete, waste arises from three sources (Sealey et al., 2001):

1. Washing out truck mixer drums at the end of each working day to prevent fresh concrete residue from setting in the drum overnight;
2. Washing down the yard and plant;
3. Occasionally unwanted fresh concrete is returned to the batching plant from site.

The causes of waste in construction are numerous, and are usually classified under two headings known as direct and indirect waste. The direct waste was generated in transport, delivery, storage, cutting, spillage, theft, vandalism, wrong use, wrong specification, learning-by-doing waste and inefficient plant, and those associated with the characteristics of the material, bespoke dimension make-up, production waste and poor workmanship are called indirect waste (CIRIA, 1993). However, it is clear that this problem requires many different considerations and involves professionals, manufacturers and industrialists.

Table 1.1 Environmental implications of construction industry and relevant considerations

<table>
<thead>
<tr>
<th>What is used</th>
<th>Where it is built</th>
<th>How it is built</th>
<th>What is build</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where raw materials are obtained</td>
<td>Location of facility; nature of terrain and ground conditions;</td>
<td>Methods of construction</td>
<td>Planning and design of facility (e.g. potential of daylight and natural ventilation)</td>
</tr>
<tr>
<td>How raw materials are extracted</td>
<td>Alternative uses immediate physical environmental;</td>
<td>Construction project management systems (e.g. quality management systems)</td>
<td>Specification, its implication for materials used</td>
</tr>
<tr>
<td>How raw materials are processed</td>
<td>Proximity to water sources and ecosystems (e.g.</td>
<td>Site control measures</td>
<td>Life-cycle economic, quality,</td>
</tr>
</tbody>
</table>
## 1.5 Sustainable development and sustainable construction

‘Sustainable development’ is defined as the development which meets the needs of the present without compromising the ability of future generations to meet their needs (Bruntland, 1987, 17). However, several authors, including Brandon (2000), note that the practical implications are vague and poorly defined. Besides, Mullaney and Pinfield (1996) argue that the two terms ‘sustainable’ and ‘development’ are incompatible because development tends to destroy the ability to sustain. A popular recent terminology now employed by The World Bank (1999) is ‘sustainable livelihood’, which discuss the dimensions of sustainability. Apparently, for achieving sustainability, the principle of sustainable development should be integrated into national and corporate policies (Ofori et al., 2000).

The term ‘sustainable construction’ is generally used to describe a process which starts well before construction (in the planning and design stages) and continues after the construction team have left the site (Hill and Bowen, 1997).
According to Wyatt (1994), sustainable construction should include ‘cradle to grave’ appraisal, not only the serviceability of a building during its lifetime, but also the recycling of resources to reduce waste streams associated with demolition should be considered. According to Hill and Bowen (1996), there are four principle attributes which construction sustainability depends on: social, economic, biophysical and technical.

Table 1.2 Principles of sustainable construction

<table>
<thead>
<tr>
<th>PILLAR ONE: SOCIAL SUSTAINABILITY</th>
<th>PILLAR TWO: ECONOMIC SUSTAINABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Improve the quality of human life, including poverty alleviation</td>
<td>● Ensure financial affordability for intended beneficiaries</td>
</tr>
<tr>
<td>● Make provision for social self determination and cultural diversity in development planning</td>
<td>● Promote employment creation and, in some situations, labour intensive construction</td>
</tr>
<tr>
<td>● Protect and promote human health through a healthy and safe working environment</td>
<td>● Use full-cost accounting and real-cost pricing to set prices and tariffs</td>
</tr>
<tr>
<td>● Implement skills training and capacity enhancement of disadvantaged people</td>
<td>● Enhance competitiveness in the market place by adopting policies and practices that advance sustainability</td>
</tr>
<tr>
<td>● Seek fair or equitable distribution of the social costs of construction</td>
<td>● Choose environmentally responsible suppliers and contractors</td>
</tr>
<tr>
<td>● Seek equitable distribution of the social benefits of construction</td>
<td>● Invest some of the proceeds from the use of non-renewable resources in social and human-made capital, to maintain the capacity to meet the needs of future generations</td>
</tr>
<tr>
<td>● Seek intergenerational equity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PILLAR THREE: BIOPHYSICAL SUSTAINABILITY</th>
<th>PILLAR FOUR: TECHNICAL SUSTAINABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>● Extract fossil fuels and minerals, and produce persistent substances foreign to nature, at rates which are not faster than their slow redeposit into the Earth’s crust</td>
<td>● Construction durable, reliable, and functional structures</td>
</tr>
<tr>
<td>● Reduce the use of the four generic resources used in construction, namely, energy, water, materials and land</td>
<td>● Pursue quality in creating the built environment</td>
</tr>
<tr>
<td>● Maximize resource reuse, and/or recycling</td>
<td>● Use serviceability to promote sustainable construction</td>
</tr>
<tr>
<td>● Use renewable resources in preference to non-renewable resources</td>
<td>● Humanize larger buildings</td>
</tr>
<tr>
<td>● Minimize air, land and water pollution, at global and local levels</td>
<td>● Infill and revitalize existing urban infrastructure with a focus on rebuilding mixed-use pedestrian neighbourhoods</td>
</tr>
</tbody>
</table>
Create a healthy, non-toxic environment  
Maintain and restore the Earth’s vitality and ecological diversity  
Minimize damage to sensitive landscapes, including scenic, culture, historical, and architectural


In terms of organization policy to attain sustainability in the construction industry, Barrie (1999) describes some major green initiatives by large UK contractors and clients. The measures of contractors include:

- Having an environmental policy and publishing an environmental statement;
- Incorporation into the annual report of an audit of the company’s contribution to green causes;
- Contribution to training in handling of materials and waste;
- Undertaking environmental audits of their buildings;
- Environmental impact assessment of some activities such as quarrying; and
- Placing a main board member in charge of environmental issues.

Also, contractors are paying more attention to corporate environmental strategy, and professional and trade bodies have been preparing ‘green’ policy papers to guide their members to adopt environmentally responsible practices (Ofori, 2000)

According to Hawken (1993), with the pressure from statutory control, intensified competition, various stakeholders, social responsibility and corporate image, business enterprises, especially those with environmental sensitivity (including heavy manufacturing, oil and chemical industry) have changed their corporate policies and operating practices and procedures. The view of environmental issues should be shifted from “moving from considering environmental issues as peripheral to business to a holistic view of business
and sustainable development” (Stigson, 1998, p.60). It is defined as following:

Moving from a focus on costs and threats to saving and opportunities;
- Shifting from end-of-pipe treatment to prevention;
- Replacing “through-put” process methods with integrated systems approaches emphasizing materials recycling and re-use;
- Viewing environmental and social issues as responsibilities throughout enterprises;
- Moving from confidentiality to transparency and accountability;
- Enhancing the communication with stakeholders including government, trade unions, non-governmental organizations (NGOs) and consumer groups.

Besides conquering the barriers of communication and feedback, successful implementation of SCM requires: senior management commitment; broad and deep changes of the attitudes of all employees; setting measurable objectives; and addressing resistance among employees through effective communication (Hewitt, 1995; Burgess, 1998).

Ofori (1992) suggested that for developing a culture of environmental protection in the construction industry, clients should adopt ‘the environment’ as a ‘fourth’ project objective in addition to the usual ones of time, quality and cost.

According to the report of Envirowise (2005), in terms of resource efficiency of the UK construction industry, there are two main drivers for change in the construction industry:
- The requirement by construction clients and contractors to demonstrate continual improvement in sustainable construction;
- The rising costs of waste disposal and construction products. These costs are being accelerated through:
  1. Higher landfill tax (increasing by £3 per tonne per year to reach at
least £35 per tonne by 2013); 
2. Higher disposal costs (as landfill sites fill up and regulatory impacts increase); 
3. Taxes and levies on primary materials (e.g. the aggregates levy)

### 1.6 Environmental management systems

By understanding the nature and impact of the environmental damage, the construction industry must take practical measures to deal with the problems. The trade-off between economic growth and the sustainability of the environment can be attained by the corporate environmental management with the company. The satisfaction of customers’ requirement for environmentally sound practices, the reduction of costs, and avoidance of infringing environmental legislation can be meet by the trade-off. An environmental management system (EMS) is required once the company decides to improve its environmental performance. According to Cascio (1996), EMS is a set of management tools, principles and procedures which an organization can use to help protect the environment from the potential impacts of its activities, products, and services.

The ISO 14000 series of standards was developed by the International Standardization Organization (ISO) in response to the trend towards sustainable development. The definition of EMS in ISO 14001 is the part of the overall management system which includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining a company’s environmental policy (Ofori et al., 2000). The ISO 14001 Standard is organized according to a five-step cycle of continual improvement, using the plan-do-check-review concept. There are many benefits from ISO
14001 which have been covered by literature (Ritchie and Hayes, 1998). These benefits can be summarized as:

- Protection of the environment;
- Reduced operating costs;
- Increased access to markets;
- Demonstrated compliance with regulations;
- Improved environmental performance;
- Improved customer trust and satisfaction;
- Enhanced corporate image and credibility;
- Employee involvement and education; and
- Potential impact on world trade to allow competition on an equal basis.

1.7 Supply chain management

The term of supply chain can be explained as the life cycle processes which supports physical, information, financial, and knowledge flows for moving products and services from suppliers to end-users (Bachok et al., 2004). Until now, there is no commonly accepted definition of supply chain management, it means that overlapping definitions exist (OGC, 2005). There are some different definitions of supply chain management:

“(the) effort involved in producing and delivering a final product from the supplier's supplier to the customer's customer” (Kranz, 1996, p. 4);

“the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders” (Lambert et al., 1998, p. 1)
Hewitt (1995) suggests that SCM is a ‘core’ or ‘strategic’ process for enterprise to link suppliers into the enterprise, and link the enterprise to its customers. SCM offers clear views of opportunities and threats of the supply chain and helps informing strategy formation (Ofori, 2000). Billington (1999) describes SCM as an ‘art’ which deserves more consideration for its power to create value.

For the implementation of SCM, Dale et al. (1994) summarize several features as following:

- Conclusion of long-term contracts between parties;
- Willingness among the parties to learn more about each other’s business operations;
- Exchange of information on business plans and operations and best practice among the parties;
- Involvement of suppliers in the customer’s product development and design processes;
- Commitment of the supplier to pursue continuous improvement by monitoring technological trends;
- Reducing the supplier base;
- Continuous development of supplier by the customer; and
- Development of trust among partners, leading to the elimination of inspections of supplied products.

The construction industry is a very fragmented industry. Because of the traditional model of planning, scheduling, controlling and contracting, where each function as different islands, the project cost would be increased to unrealistic values (Bachok et al., 2004). The construction supply chain process includes different stages in the construction process (Seeley, 1997):

- Briefing stage (comprising of inception and feasibility)
- Design stage
Construction supply chain (CSC) embodies all construction processes, which starts at the initial demands by the client/owner, to design and construction, maintenance, replacement and eventual demolition of the projects. It also consists of different organizations involved in the construction process, including client/owner, designer, contractor, subcontractor, and suppliers. CSC is both a chain of construction businesses with business-to-business relationships and a network of multiple organizations and relationships. The chain includes the flow of information, materials, services, products, the flow of funds between owner, designer, contractors, subcontractors, and suppliers (Xue et al., 2005). According to Muya et al (1999), there are three types of CSC:

1. the primary supply chain, which delivers the materials that are incorporated into the final construction products;
2. the support chain, which provides equipment and materials that facilitate construction;
3. the human resource supply chain which involves the supply of labour.

According to Xue et al. (2005), construction supply chain management can be defined as:
Construction supply management focuses on improving total project performance along various metrics including speed, cost, and quality. The integration of the supply chain management should aim at efficiency and effectiveness improvement across all chain members, this aspect is suggested by Ofori (2000) as the most relevant to the construction industry.

1.8 Green supply chain management

Environmental management is becoming a key strategic issue for organizational performance as companies increasingly realize their environmental responsibilities. Environmental impacts occur across all stages of a product's life cycle, from the raw material extraction, to manufacturing, use and reuse, final recycling, or disposal, namely from cradle to grave (Zhu and Sarkis, 2006). Therefore, green supply chain management (GSCM), as well as other related principles, has become an important strategy for companies to achieve profit and market advantages by reducing the environmental risks and improving efficiency (Sarkis, 1995). For a long time, the importance of GSCM
has been raised by environmental standard such as ISO 14000 system of standards and the parallel European Union's EMAS (Rao, 2005)

The definition of GSCM is still not clear, because the combination of corporate environmental management and supply chain management is a relatively new area of study and practice (Zhu and Sarkis, 2004). A number of possible definitions of GSCM have been put forth since the 1990's including:

“Environmental supply chain management consists of the purchasing function’s involvement in activities that include reduction, recycling, reuse and the substitution of materials” (Narasimhan and Carter, 1998, p.6);

“The practice of monitoring and improving environmental performance in the supply chain” (Godfrey, 1998, p.244);

“The term ‘supply chain’ describes the network of suppliers, distributors and consumers. It also includes transportation between the supplier and the consumer, as well as the final consumer… the environmental effects of the researching developing, manufacturing, storing, transporting, and using a product, as well as disposing of the product waste, must be considered” (Messelbeck and Whaley, 1999, p. 42).

There are ranges of focus and purpose of GSCM because of the variety of research or practitioner field. The purpose of GSCM ranges from reactive monitoring to proactive practice. A range of aspects on green supply chain management have been covered, including GSCM drivers and/or pressures and GSCM practice (Zhu and Sarkis, 2006).

There are various explanations why firms should engage in GSCM activities.
Besides overall environmental improvement, Hall (2000) suggests that large firms have to meet stakeholder pressure beyond legal environmental responsibilities and many suppliers are under considerable pressures from their customers. According to Henriques and Sadorsky (1996), there are five critical environmental stakeholder groups: (1) regulatory stakeholders, which set regulations or can convince government to set standards; (2) organizational stakeholders, who are directly related to an organization and can affect the company financially; (3) community groups, environmental organizations and other lobbies who can change public opinion for or against a firm's environmental policies; (4) the media, which can influence the public perception of a specific firm; and (5) customers, which are the most vital stakeholders of any companies. However, not all organizations are facing the same pressures or to the same extent (Zhu and Sarkis, 2006). Different industry sectors of different countries are facing different pressures (Christmann and Taylor, 2001). For example, Bristol-Myers Squibb, IBM and Xerox have encouraged their Chinese suppliers to implement environmental management systems consistent with ISO 14001, while, suppliers of Ford, GM and Toyota are required to obtain the ISO certification (GEMI, 2001). Furthermore, some latest global environmental issues are much more sensitive than others and will be emphasized. For example, the Kyoto Protocol requires the reduction of greenhouse gas emissions, therefore, those industries which are heavy emitters of greenhouse gases (e.g. power generation) will be subjected to increased pressures. Other industries which are more globally focused (e.g. electronic or clothing and shoes) will bear both national and international pressures and motivations for incorporating GSCM practice (Zhu and Sarkis, 2006).

GSCM practices range from green purchasing to integrated supply chain flowing from suppliers, to manufactures, to customers and reverse logistics. According to Zhu and Sarkis (2006), five GSCM practices can be used to
improve their performance, including internal environmental management, green purchasing, cooperation with customers, investment recovery, and eco-design practices. These five GSCM practices are integrated into each other and need cross-functional cooperation. Internal environmental management is most significant for the improvement of enterprises’ performance (Melnyk et al., 2002). Large customers can impose pressures on their suppliers with requirements of better environmental performance. Therefore, companies and enterprises need to cooperate with customers for environmental objectives (Zhu and Geng, 2002). Green purchasing and eco-design focus on the inbound or early stages of a product’s supply chain. Investment recovery is considered as a critical aspect for GSCM practices of United States and European (Zsidish and Hendrick, 1998). However, because of the lack of waste management policies and recycling systems, investment recovery in China is not considered to be as important as in developed countries.

1.9 Green purchasing

According to Ofori (2000), the increasing environmental consciousness and commitment of businesses, governments, and individuals has inspired the development of procurement and purchasing policies incorporated with environmental requirements. Walton et al. (1998, p. 2) say:

“In business today, companies cannot ignore environmental issues. Increasing government regulation and stronger public mandates for environmental accountability have brought these issues into the executive suite, and onto strategic planning agendas. At the same time, companies are integrating their supply chain processes to lower costs and better serve customers. These two trends are not independent; companies must involve suppliers and purchasers to meet and even
exceed the environmental expectations of their customers and their governments “.

According to Stock (1992), the life-cycle issues of the ultimate disposition of materials must be considered as an integral part of the purchasing and procurement process. Green purchasing has been covered in some literature: according to Hamner and Del Rosario (1998), green purchasing is an increasingly common practice which is effectively greening the supply chain, and is becoming a key component of SCM. Walton et al. (1998, p. 2) suggest that companies should integrate other members of the supply chain into their environmental management processes. With objective environmental criteria which are developed systematically, the supplier evaluation systems can influence supplier’s behaviour effectively.

Carter et al. (1998, p. 28) suggest green purchasing consists of “purchasing’s involvement in activities that include reduction, reuse, and recycling materials”. Also, they find that many firms are developing and implementing “green” strategies to preserve the environment, as well as enhance efficiency and effectiveness.

In 1993, the UK Chartered Institute of Purchasing and Supply launched voluntary guidelines entitled “Buying into the Environment” (Anonymous, 1993). There are several principles in it:

- Establishment of a business case to make environmental purchasing viable and part of day-to-day operations;
- Understanding of environmental issues related to the organization and its supply chain;
- Development of a purchasing policy which addresses environmental issues;
- Formulation of environmental criteria for ranking suppliers;
• Evolution of suitable methods for information collection; and
• Establishment of agreed targets for further environmental performance improvements by suppliers.

Recently, green purchasing in construction has been covered in related literature. Ofori (1999) explains examples of green purchasing in construction. Besides, programmes in Sweden, France and the US which involve the collaborative purchasing by influential groups of buyers, of products with specified performance criteria in the construction areas. It is proved that reduction in resource use of 30-50% has been achieved in a short period (Westling, 1998). According to his theory, some actions should be advocated:
• Development of several principles for formulating requirements and testing, and contract rules including warranties and long-term responsibilities;
• Preparation of international performance standards; and
• Review of international rules for public-sector procurement to enable them to stimulate further innovation in sustainability.
Chapter 2 Research design and method

2.1 Introduction

The methodology was designed to generate the most suitable data to achieve the aim and objectives of this research. Two main methods of research were used. A desk study covered the basis of the research and the scope. To acquire the knowledge of construction industry, supply chain management and green procurement, related journals and publications have been read.

A questionnaire survey was conducted to collect the information about the implementation of green supply chain management in construction industry.

2.2 Desk study

The desk study had two primary objectives: to examine the environmental impact of the construction industry within the materials area; and to acquire information about sustainable construction, green supply chain management, and the link between them. Based on the broad literature review, the background information was collected to design the questionnaire.

2.3 Questionnaire

The research technique employed for the collection of data was a self-completion questionnaire, administered to respondents via email. A period of 3 weeks was allowed for the return of questionnaires.

According to Bryman (2001) and Tang (2003), the use of a self-completion questionnaire has several advantages. The cost and weight involved the large
sample size is reduced. Compared with mail or personal and telephone interviews, being quick to administer is an advantage.

It is acknowledged that there is a tendency for self-completion questionnaire to generate lower response rates than comparable interview surveys (Bryman, 2001). Several techniques were used to make a positive reply possible:

A covering letter which explained the purpose and the potential benefits of the research was attached to each questionnaire. It was also assured that all the information provided by respondents will be kept confidential and will not be used for any purposes unrelated to the dissertation. At the same time, to maintain the interest of the reader, the covering letter was limited to less than 200 words.

The questionnaire was also interpreted into Chinese for the selected respondents in China. However, because of cultural barrier, minor modification of the covering letter was completed to gain the interest of these respondents.

Selected companies which failed to respond after three weeks were sent another email in order to prompt them to participate in the research. If requested by the respondents, the summary of the questionnaire results and dissertation finding will be sent to them.

Closed questions might have reduced the spontaneity of their response. In order to increase clarity and ensure that respondents were fully understood, technical and ambiguous terms were avoided. The last part of the questionnaire was set aside for any recommendation from the repliers.

The questionnaire first asks for general information about the company. Questions 1 and 2 require the name of the company and the approximate
Questions 3 and 4 ask whether the company has an environmental management system; if yes, which one; and how successful the environmental system is supposed to be. Question 5 asks about the environmental pressures for the company. There are three choices for this question. The first one is “yes, the environmental issue is one of the top priorities of the company policy and we have improved it with proactive operation during construction projects”. This kind of response indicates that the company has been realizing the importance of protecting the environment during its operation and adopted a “green” policy within the organization. The second answer is “sometimes, we realize some activities of the projects are related to environmental performance. However, we just fulfil the legal compliance”. This kind of answer implies that there is no ambition within the company to adopt proactive policy but only reactive compliance with legal requirements. The answer C is “never”, the choosing of this answer reflects the lack of environmental responsibility of the company, because of the environmental issues related to construction industry which have been described, there should be some environmental implication of the company’s practices. Question 6 asks who is laying the load of environmental pressures to the company. As has been mentioned, there are several kinds of critical environmental stakeholder groups including government, media, local resident, contractor and client, and other stakeholders. Question 7 concentrates on finding out which environmental issues are the priorities for the company’s environmental performance. It is based on the company’s operation and the specific project practices. However, by investigating this approach, it is helpful to figure out which environmental issues are generally the most significant from the view of the industry.

The next part of the questionnaire focuses on investigating specific information about the green procurement of the construction industry. According to
Hamner and del Rosario (1998), green purchasing strategies can be categorized into four groups: product standards, behaviour standards, collaboration, and development. Based on this framework, information of specific green purchasing activities in the construction industry is investigated separately. Due to the variety of construction practices and features of construction materials used, only descriptive features of these activities but not specific information focusing on any kind of materials are applied into the questionnaire. There are three answers for each of these questions including ‘YES’, ‘NO’, and ‘SOMETIMES’ to avoid absolute conclusion of company’s activities.

<table>
<thead>
<tr>
<th>Category</th>
<th>Activity</th>
</tr>
</thead>
</table>
| **Product standards** | Purchase products with environmentally friendly attributes, such as recycled materials, and those with non-toxic ingredients  
Purchasing products that disclose their environmental attributes, such as those which have been eco-labelled.  |
| **Behaviour standards** | Require suppliers to disclose information about their environmental practices, pollution discharges, and so on  
Audit suppliers to evaluate their environmental performance  
Require suppliers to implement and maintain environmental management systems  
Require suppliers to obtain certification of their environmental management systems to a recognized standard such as ISO 14000 |
| **Collaboration**   | Work with suppliers to help them reduce environmental impacts through changes in product design and materials use  
Implement product stewardship programmes throughout all stages of a product’s life cycle. |
| **Development**     | Institute training programmes for suppliers to increase their knowledge of environmental implications of the company’s, and their own activities and Inform suppliers of technological developments relating to their operations. |

Source: Hamner and del Rosario (1998)
The last question tries to find out how these companies think about green supply chain management in the construction industry. Is it beneficial for short-term environmental improvement or long-term sustainable development? Is it difficult to implement green supply chain management in this industry? At the same time, does it have the potential for the company itself and suppliers to play a win-win game?

2.4 Questionnaire distribution and response

Questionnaires were finished with both English and Chinese versions for companies of the UK and China. It was copied as an excel document and sent as an email attachment to companies with a cover letter. The acquirement of contact information of the UK construction companies was based on a contact list in an MSc dissertation of University of East Anglia, which focuses on the integrated management system in the UK construction companies (Tang, 2003). Besides of this, more contact information was collected from the ISO 14001 Database (EMAS, 2006). Due to the lack of contact information supplied on the internet for Chinese construction companies, assistance was acquired from China for the collection of the information including. Colleagues and friends supplied assistance of contact information.

Eventually, 11 completed questionnaires out of 57 were returned from the UK construction companies with a response rate of 19%; for the Chinese construction companies, 32 questionnaires were sent out with 9 returning. The response rate is 28%. Totally, the response rate for the whole research from construction companies is 23%. About half of the responses had interests to obtain a summary of the questionnaire results and the research findings.
Chapter 3 Data analysis and discussion

3.1 Results

The survey shows that most of the responses have been implementing environmental management system. Totally, all the UK construction companies have an environmental management system and 9 out of 11 have been certified by ISO 14001, and other 2 companies have one but not certified. For the Chinese companies, two thirds of the responses have environmental management systems which have been certified by ISO 14001, and 2 companies have not been certified yet. Only one of these companies has no environmental system.

![Figure 3.1 EMS implementation within the UK construction companies](image)

![Figure 3.2 EMS implementation with China construction companies](image)
Based on the literature review, the implementation of EMS has several benefits. Apparently, most of the responses both from the UK and China have realized the potential to gain these advantages through implementing an EMS. However, the rate for the certification of the two countries is different. Companies from the UK construction industry have a little higher certification rate, and notably, there is one Chinese company which has no EMS. The data shows that most of the responses from both UK and China think the implementation of EMSs in the corporation is successful. However, the satisfaction rates indicate that the implementation of EMS in the UK companies is better than their Chinese competitors. It implies that the UK construction companies have attained more benefits by implementing an EMS.

The data shows that all the responses from the UK industry have realized the environmental implication with their practices. 7 companies out of 11 have set environmental issues as part of the top priorities of the company policy. The other 4 companies say that they just comply with legal requirements. For the Chinese construction companies, one third of the responses have added environmental issues into their policies and have established proactive operation during the projects. Nearly half of the Chinese responses just fulfill the legal requirements. Surprisingly, there are 2 companies think they feel no
environmental pressures, one is the company which has no EMS, and the other is seeking for the certification of EMS. The possible reason for this situation is acquiring the ISO 14001 certification increases the access to the market and enhances the image of the companies.

Figure 3.3 Environmental pressures for the UK construction companies

![Pie chart showing environmental pressures for the UK construction companies. 64% prioritize company policy, 36% only fulfill legal requirement.]

Figure 3.4 Environmental pressures for China construction companies

![Pie chart showing environmental pressures for China construction companies. 33% prioritize company policy, 45% only fulfill legal requirement, 22% no environmental pressure.]

The literature review about the environmental pressures have covered five groups of stakeholders: (1) government as regulatory stakeholders; (2) media; (3) local resident as community groups; (4) contractors and clients; and (5) other stakeholders including related organization which can affect the
company financially and so on. The data shows that all the responses from UK feel the pressures from local residents. Meanwhile, the government, contractors and clients, and other stakeholders are supposed to be the creators of environmental pressures by most of these companies. Less than one third of the responses think the media is creating the pressure. For the construction companies of China, media and local resident are the top two environmentally critical groups, 5 companies think the two groups of stakeholders are creating the pressures. One third of the responses from China think the government and other stakeholders are creating pressures for the environmental performance.

Figure 3.5 The environmentally critical stakeholders for the UK construction companies

![Bar chart showing the number of companies for each group of stakeholders](image)

Figure 3.6 The environmentally critical stakeholders for the UK construction companies
According to the data for the priority environmental issues, the UK construction companies consider waste management issues are the most important issue for their operation. 10 companies category it into the top 3 priority environmental issues. The reason for this attitude is due to the rising costs of waste disposal and construction products which has been mentioned in chapter 2. The landfill tax will reach at least £35 per tonne by 2013, and as landfill sites fill up, the regulatory impacts will also increase. Notably, except the waste management issue, less than half of the responses from the UK think the other environmental issues are their priority for the environmental performance and improvement. Four issues including soil, noise, flora and fauna, and climate change are supposed to be one of the priorities by 4 or 5 companies. Environmental issues of air, water, and other issues are at the bottom of the priorities of these companies.
Figure 3.7 The priorities of environmental performance issues in the UK construction companies

Figure 3.8 The priorities of environmental performance issues in China construction companies

According to the data, the situation in China is a little different from UK. The environmental issue of noise pollution ranks the first place as two thirds of the Chinese companies think the noise is one of their environmental priorities. More than half of the responses think waste management is one of their priorities, followed by the issues of air, soil, water, flora and fauna. It is notable that none of these responses puts issue of climate change and any other...
issues into their priorities for the environmental performance.

The survey shows that most of the responses from UK and China have committed to purchase construction materials with environmentally friendly attributes, such as recycled materials, and those with non-toxic ingredients. 9 (82%) companies from UK always buy green construction materials. The other 2 (18%) companies implement this purchasing strategy occasionally. Similarly, 6 (67%) companies from China construction industry always buy green construction materials leaving the remaining of 3 (33%) companies who buy green construction materials sometimes. Basically, companies from the two
countries have the similar approach to the green materials purchasing. One of the reasons is for the satisfaction of clients. As the awareness of environmental protection, customers have been focusing on the total quality of the construction products including the environmental performance of the construction throughout the whole life cycle. Another reason is the increased requirement of regulation. Materials with toxic ingredients are forbidden to use and recycled materials have been encouraged into the material market.

The requirements for information disclosing, auditing, EMSs implementation and EMSs certification are described as the behaviour standards (Hamner and
del Rosario, 1998). For the information disclosing, responses from the two countries show different approaches. Nearly three quarters of the UK responses always require their suppliers to disclose information about their environmental practices, pollution discharges, and so on. The other 3 companies (27%) say they have this requirement for the suppliers sometimes. However, in China, only one company of the responses has the positive answer that claims they implement this strategy for the suppliers all the time. 5 companies (56%) load this requirement to their suppliers as an “occasional” attitude. And other 3 companies have no this requirement for their suppliers. The answers of “sometimes” have a connotative meaning of “seldom”. The data shows that companies from the two countries have different approaches.

Figure 3.13 Auditing suppliers to evaluate their environmental performance in the UK companies

![Pie chart showing the responses of UK companies regarding auditing suppliers.]

- Always: 55%
- Sometimes: 27%
- No: 18%
The situation for the auditing of suppliers environmental performance is similar for companies from UK and China. More than half respondents audit suppliers to evaluate their environmental performance sometimes. Only 3 (27%) and 1 (11%) companies from UK and China always have this behaviour standard for their suppliers.
For the requirement of EMSs implementation and maintenance, the data shows different approaches of the responses from the two countries. Only 1 (9%) company of the 11 responses from UK has no requirement for its suppliers to achieve this standard. However, nearly half (4 out of 9) of responses from China are in the same situation. 8 (73%) companies from UK and 3 (33%) companies from China require their suppliers of this standard sometimes. Notably, the number of 2 of the China responses is 1 more than the number of the company from UK which always has this requirement for their suppliers.
Besides the implementation of EMSs, according to the strategies of green purchasing in chapter 2, the certification of ISO 14001 is important for the quality of the system operation. Nearly half of the UK responses have no requirement of certification of EMSs for their suppliers. Similarly, a little more than half of the responses from China also have no such requirement. Companies from the two countries who always need certificated EMSs for their suppliers are also the companies who always require EMS implementation. Totally, half of the 20 responses have no requirement for their suppliers to acquire a certificated EMS.
Figure 3.19 and 3.20 illustrate that the co-operation in the UK companies is better than in China. 5 (45%) companies from UK always co-operate with their suppliers to reduce the environmental impacts of their suppliers through changes in product design and materials use. And 55% companies do this sometimes. The situation for the China responses is different. Apparently, one third of these companies never co-operate with their suppliers to deal with this kind of issue. Only 1 company (11%) always co-operates with its suppliers to reduce their environmental impacts.

Figure 3.21 Institute training programmes for suppliers to increase their knowledge of environmental implications in the UK companies

45% 55%

Always Sometimes
The data in figure 3.21 and 3.22 shows that all the responses from UK have instituted training programmes for their suppliers to increase their knowledge of environmental implications. More than half of these responses always train their suppliers for the awareness of environmental protection. However, in China, 5 companies (56%) have no training programmes for their suppliers. The remaining 4 companies do it sometimes. It is clear that the development for the green purchasing in the Chinese companies is weaker than the responses of UK.
Figure 3.23 and 3.24 show that the situation for informing suppliers of technological developments relating to their operations in the two countries. Nearly half of the responses from the UK do not inform their suppliers this kind of information. Two thirds of the Chinese responses are in the same situation. Only 2 companies (18%) inform their suppliers the information.
As the figures show, most of the responses from the two countries agree that it is long-term beneficial for sustainable development. About half of the UK responses think it is also possible to acquire short-term environmental benefits by improving suppliers’ action. However, only 2 Chinese companies (22%) agree. 7 companies from the UK think it has potential to gain mutual benefits for both the company and suppliers, only 3 Chinese companies agree it. With the notion of potential win-win situation, the UK companies have paid more attention to this area and it is also approved by the analysis of green purchasing activities of the two countries.

To summarize, the analysis of the questionnaire data found:

- Most of the surveyed companies from China and UK have realized their environmental implication within their activities;
- Responses from the two countries think local residents are a pressure creator for their environmental performance, however, in China, the media is also one of the main pressure creators;
- Waste management is the most important environmental issue for the UK responses, however, in China the most concerned issue is noise;
- For the green purchasing activities, companies from the two countries
have the similar product and behaviour standards for their suppliers, however, the situation of co-operation with suppliers and development for the green purchasing in the UK is better than in China; and

- It is believed that green supply chain management is beneficial for the sustainable development in the construction industry.

It is important for the construction industry to increase the knowledge of green procurement, especially for the construction industry of China. Some initiatives would be helpful (Ofori, 2000):

- Developing expertise in SCM within industry;
- Training purchasing officers in key aspects of green procurement including performance evaluation and monitoring;
- The government should provide direct support through its procurement policies and procedures;
- Offering incentives to support clean production processes and practices;
- Promoting environmental responsibility among all construction agencies, enterprises and practitioners;
- Improving the best practices in green procurement;
- Instituting an annual competition in enterprises to recognize excellence in green procurement;

3.2 Evaluation and recommendation

Prior to this dissertation there is little research which has covered the comparison of the green supply chain management in the UK and China construction industry. However, the literature review can be promoted and supplemented by the research.
Because of the flexibility of the green supply chain management in construction industry and the time restriction, it is impossible to cover the whole green supply chain management in this dissertation. Only the flow of construction materials is mentioned from the suppliers to the builders. However, the effects of customers are out of the scope of this dissertation.

There are several limitations of the questionnaire. Some of the email addresses are outdated and it is the main reason for the low response rate. Because of the instinct of the corporation, some answers of the questionnaire seemed to be “social acceptable”, the credibility of the answer is still doubtable in some sense. It is also educible that most respondents who have replied the email are usually have comparatively “good” environmental performance, others who think they are in poor condition do not want to respond. The questionnaire is limited to the surface of the general perception and activities of the companies, no specific detail about the daily operation is investigated in the questionnaire. The choosing of the companies from the two countries is random. The corporation sizes of the responses are various, some of these companies are SMEs and have different corporate culture compared with other multinational companies of the sample. Also, the size of the sample is another problem. The use of green procurement activities in the questionnaire are only based on the general approach for green purchasing.

As the green supply chain management is a new area in construction industry, much research is still at the theoretical level and little has been proved within the construction industry. Therefore, it is also too early to investigate the long-term benefits for the sustainable development but just only the perception of these companies.

For the further research of this study, some key issues should be covered:

- For the comparison between developed and developing countries, how to
improve a robust framework which considers all the factors including politics, culture, social system, and so on.

- Development of a quantitative analysing method for the performance of green supply chain management in construction industry, the comparison with other sectors would be helpful.
- Widening the research area from materials flow to the whole supply chain, and developing a systematic approach from the views of companies, suppliers, and the final consumers.

3.3 Conclusion

This research intends to investigate the actuality of green supply chain management in the UK and China construction industry. Prior to this, many researchers have covered the green supply chain management and the initiatives and pressures for the implementation.

Through a desk study about the environmental implementation of construction industry and green supply chain management, the foundation of this research is completed. According to the literature review, green supply chain management can obtain sustainable development in the construction industry for the goal of “sustainable construction”. A survey which focuses on the construction materials flow from the suppliers to the builders is conducted between the UK and China construction companies.

The survey finds that most of the responses from the UK and China have awareness about the environmental implication of their activities. Based on the green purchasing activities, one questionnaire is used to investigate the situation of the responses from the different countries. Companies from both of the countries have been implementing GSCM, however, the UK companies
keep ahead in the co-operation with their suppliers. Besides, the perception of GSCM, the creator of pressures for GSCM is different for the companies from the two countries.

To help enterprises enhance the awareness of GSCM, a group of initiatives which includes categories of education, support, promotion, and best practices has been developed.
References


CIB Commissions W65 and 55, Cape Town, Vol. 1, September, pp. 41-56.


ENDS Report 360, January 2005, p 54

Environmental information centre. 15/01/03 POLLUTION PREVENTION AND ABATEMENT FOR CEMENT INDUSTRY
http://www.cleantechindia.com/eicimage/2102_42/PPACI.htm viewed 05/07/06


Ofori, G. 1999. Satisfying the customer by changing production patterns to
realise sustainable construction. Proceedings, Joint Triennial Symposium of


Appendix 1: Questionnaire Cover Letter

Dear Madam/Sir,

I am a student of the University of East Anglia and am currently undertaking my Masters dissertation, which deals with the green supply management in the construction industry.

The aim of my dissertation is to search how green supply chain management is operated in both the UK and China? And who is making pressures to it?

I very much hope that you will be able to help me with information about how your company deals with these kinds of issues. For the purpose of my dissertation individual companies will be treated anonymously. I would be most grateful if you could take 5 minutes to finish the questionnaire I attach to this email. If you can possibly sent it back to me by email before 5th of August (xiao.xiao@uea.ac.uk or antony_xiaoxiao@hotmail.com), it would be very helpful to me.

If you would like, I would like to send you a short summary of my dissertation including the questionnaire findings, when it is completed in August.

Thank you for your help.

Yours Sincerely

Xiao Xiao
Appendix 2: Questionnaire

Green supply chain management in construction industry

1. Company Name

2. Approximate annual turnover: £/year

3. Does your company have environmental management system?
   A  Yes, and has been certified
   B  Yes, but not certified
   C  No (go to Q. 5)

   If yes, which one?
   A  ISO 14001
   B  EMAS
   C  Other standard

4. How successful do you think the environmental management system has been?
   (Please circle your choice)
   (poor) -2 -1 0 1 2 (good)

5. Are there any environmental pressures your company is facing?
   A  Yes, the environmental issues is one of the top priorities of the company policy and we have improved it with proactive operation during construction projects
   B  Occasionally, some activities of the company are related to environmental performance. However, we just fulfill the legal requirements
   C  Never

6. Who is creating the pressures? (please circle as many as you like)
   the government
media
local resident
contractors
other stakeholders

7. Please select top 3 priorities for the company’s environmental performance

Soil
Air
Water
Waste
Noise
Flora and fauna
Climate change
Other issues

8. Does your company

Purchase construction materials with environmentally friendly attributes, such as recycled materials, and those with non-toxic ingredients?
Yes/ No/ Sometimes

Require suppliers to disclose information about their environmental practices, pollution discharges, and so on?
Yes/ No/ Sometimes

Audit suppliers to evaluate their environmental performance?
Yes/ No/ Sometimes

Require suppliers to implement and maintain environmental management systems?
Yes/ No/ Sometimes

Require suppliers to obtain certification of their environmental management systems to a recognized standard such as ISO 14001?
Yes/ No/ Sometimes

Work with suppliers to help them reduce environmental impacts through changes in product design and materials use?
Yes/ No/ Sometimes

Institute training programmes for suppliers to increase their knowledge of environmental implications of the company’s, and their own activities?
Yes/ No/ Sometimes

Inform suppliers of technological developments relating to their operations
Yes/ No/ Sometimes

9. What do you think about green supply chain management in the construction industry?

A. It is long-term beneficial for sustainable development
B. It has short-term environmental benefits by improving suppliers' action
C. It is difficult to set out because of some reasons (e.g. company culture, government policy and market demand)
D. It is waste of resource (money and human resource)
E. It has the potential for the company and suppliers to acquire mutual benefits

Any recommendation here:

END