

A green supply chain assessment for construction projects in developing countries

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Abstract

As a result of global warming, organizations have been improving their sustainability and environmental performance in terms of reducing their carbon emissions, minimizing waste generated from the industry, conserving natural resources, and reducing energy consumption. Green Supply Chain Management (GSCM) is one of the applications in which organizations should implement essential environmental aspects. Although GSCM initiatives have been taken by some construction firms, some firms are not aware of the benefits of its practices to their companies and the society. This research paper presents a framework for identifying essential GSCM requirements for the construction industry through literature review and interviews with experts by pointing out the various drivers and barriers of GSCM in developing countries and providing recommendations for improvement. Two case studies are presented to evaluate the GSCM practices performed in two construction companies in Egypt, identifying the drivers and barriers as well as suggesting proposals that will improve the efficiency of the companies' environmental performance. The findings of the study indicate that the drivers of implementing GSCM in Egypt include ISO 14001 certification and market competitiveness, while the main barriers include lack of regulations, lack of government support, and lack of society pressure. It also indicates that the implementation of GSCM in Egypt can be achieved through coordination between various parties such as governments, owners, manufacturers, consultants, contractors, society and NGOs and universities.

Keywords: supply chain management, green construction, sustainability, developing countries, logistics, materials.



1 Introduction and problem statement

Nowadays, as a result of global warming and environmental problems worldwide, construction firms are required to consider their sustainability and environmental performance. The United Nations Environmental program in 2007 stated that the construction sector is responsible for 30–40% of the total carbon emissions worldwide (Balasubramanian [1]). As such, construction firms are working on improving their sustainability performance. The ISO 14001 – Environmental Management Systems certification- statistics for 2011 shows that the highest number of ISO 14001 certificates among the industries is in the construction sector with a total of 34155 certificates (ISO [2]). One of the practices where organizations should consider environmental aspects is the supply chain management. Supply Chain can be defined as “the movement of materials as they move from their source to the end customer” (Dube and Gawande [3]). There is a need for a Green Supply Chain management as it aims to conserve natural resources, reduce generated waste through reusing, recycling, and remanufacturing the materials, and reduce pollution. It includes green design, green operations, reverse logistics, waste management and green manufacturing. There are a number of definitions of GSCM such as: “supply chain environmental management”, “green purchasing and procurement”, “green logistics and environmental logistics” and “Integrating environmental concerns into the inter-organizational practices of SCM including reverse logistics” (Sarkis *et al.* [4]). There are various reasons that may encourage or even force companies to implement GSCM, such as the environmental law, industrial competitiveness and society pressure. GSCM, however, is more common in food industry, automobiles and electronics rather than construction industry. For example, Pepsi cola saved about \$44 million as a result of using recyclable plastic shipping containers instead of corrugated containers for one liter bottles and this conserved 196 million pounds of corrugated materials (Dube and Gawande [3]). There has been also a lack of research of implementing GSCM in the construction sector especially in developing countries, such as the case of Egypt. As such, the main objectives of this paper are to:

- 1- Identify drivers and barriers of applying GSCM in developing countries, with a focus on Egypt as an example.
- 2- Develop a comparison between an international model and a local model of construction firms in developing countries in order to identify the defects and suggest proposals for solution.

2 Literature review

There is a patent difference between the traditional supply chain management and green supply chain management in construction industry. Sarkis [5] defined three key elements where environmental aspects should be considered for converting traditional supply chain into Green Supply chain, namely: product



lifecycle, operational life cycle and waste minimization. The main categories are divided into sub categories as follows:

The product lifecycle consists of four phases: product introduction phase, growth phase, maturity phase, and decline phase. The product introduction phase is the design phase. Dube and Gawande [3] stressed that designers should consider the impact of their design on energy and materials required for manufacturing in addition to designing products that can be remanufactured, recycled and repaired. They also mentioned that for a green design designers should consider the reverse logistics benefits. The second phase is the growth phase and in this phase reverse logistics shall be considered to facilitate the recycling and remanufacturing of the products. Sarkis [5] mentioned that in order to improve the environmental performance in maturity and decline phases, processes should be improved and reverse logistics should be efficient.

The operational lifecycle includes: procurement, production, transportation, reverse logistics, and packaging. According to Dube and Gawande [3] green purchasing and procurement can be defined as “The integration of environmental considerations into purchasing policies, programs and actions.” In order to implement GSCM, the organization should be ready and willing to purchase recyclable or reusable materials, especially from suppliers who have ISO 14000 certification (Sarkis [5]). Similar to cost and quality, the criteria of contract award should be based on environmental aspects. According to Balasubramanian [1], Jojoba is one of the organizations that use an assessment tool to evaluate the suppliers’ environmental performance. The suppliers have to fill a questionnaire that examines their compliance with the environmental policies and standards. In case the supplier does not meet the required ethical standards, the organization supports them to enhance their performance (Balasubramanian [1]). The production processes have an impact on GSCM by selecting materials that can be recycled or remanufactured and processes should be designed to reduce or prevent wastes (Sarkis [5]). Moreover, distribution and transportation are important factors in the operational life cycle. For the implementation of GSCM within the organizations, a number of factors should be considered. For example, the distribution outlet location is an important factor. The nearer the outlet the more it saves the fuel, minimizes the costs of transportation, and reduces the pollution generated from the vehicle. It is suggested to link organization’s location decisions to those of both suppliers or vendors and customers in order to improve the just in time policy (Sarkis [5]). GSCM also requires the selection of the means of transportation that has the least negative effects on the environment. Within the operational lifecycle, environmental reverse logistics can be defined as “the return of recyclable or reusable products and materials into the forward supply chain” (Sarkis [5]) Another definition is “a process where manufacturer accepts previously shipped products from the point for consumption for possible recycling and remanufacturing” (Dube and Gawande [3]). It consists of a number of stages namely; collection of materials followed by separation, densification, transitional processing, delivery and integration and these stages may differ according to the industry, the type of the product and the requirements and it may differ as well from an organization to another (Sarkis *et*



al. [4] and Sarkis [5]). Reverse logistics has two major benefits; conservation of natural resources and reducing costs required to manufacture new products. As for packaging, there are a number of characteristics to be considered in order to convert traditional packaging to green packaging such as size and shape (Sarkis [5]). Green packaging reduces material usage, allows for a better space utilization in stores and reduces the amount of handling equipment and the required resource. Green packaging requires strong relationships with suppliers in addition to a strong reverse logistics channel. Some countries have legislation for returnable packaging (Sarkis [5]). For example, Xerox has implemented green packaging by changing its packaging policy, establishing packaging-reuse centers in countries like UK and USA as well as reducing the internal packaging for waste minimization (Dube and Gawande [3]).

The last of the three environmental aspects of GSCM is waste management that includes five main elements namely, reduce, reuse, recycle, remanufacture and disposal (Sarkis [5]). The reduction of the wastes can be achieved using programs like total quality management and just in time programs (Sarkis [5]). The other four processes reuse, recycle, remanufacture and disposal are called the end of pipe practices. Reuse practices keep the physical structure of the product but with substitution, remanufacture requires disassembly of the parts, while recycle can change the physical and chemical characteristics of the material being recycled (Sarkis [5]).

In addition to the above requirements for the application of GSCM, various drivers of its implementation were either identified by previous researchers or through interviews with experts as follows:

1. Regulations and ISO certification, e.g. ISO 14001 (Walker *et al.* [6], Diabat and Govindan [7]).
2. Customer demand, customer pressure and marketing pressures (Walker *et al.* [6]).
3. Governmental support in terms of incentives and tax reduction (Experts Interviews).
4. Improving environmental performance of the organization and market competitiveness (Walker *et al.* [6]).
5. Government compliance, Corporate Social Responsibility, reverse logistics and economic drivers (Dube and Gawande [3]).
6. Public and NGOs pressure (Walker *et al.* [6]).
7. Green supply management capabilities, strategic level of purchasing department, level of environmental commitment, degree of green supplier assessment, and degree of green collaboration with suppliers (Large and Thomsen [8]).
8. Suppliers' integration (Walker *et al.* [6]).
9. Ethics and values of parties involved (Walker *et al.* [6]).
10. Conserving natural resources by reusing and recycling materials and packaging (Diabat and Govindan [7]).
11. Employees' willingness to improve their positions in the firm and middle and top management support (Walker *et al.* [6]).



12. Regulations, Society pressure and fear of being criticized by customers (Experts Interviews).
13. Employee involvement and improving the quality (Walker *et al.* [6]).
14. Reducing costs (Walker *et al.* [6]).
15. Green design, reducing energy consumption and reverse logistics (Diabat and Govindan [7]).
16. Environmental collaboration with customers and suppliers, and government legislation and regulation (Diabat and Govindan [7]).

On the other hand, a number of external and internal Barriers that hinder the implementation of GSCM have been identified. External barriers include the following:

1. Green suppliers and products are not available (Varnäs *et al.* [9]).
2. Lack of green architects, suppliers, developers, experts, and professionals in the field of sustainability and GSCM in developing countries (Balasubramanian [1]).
3. Unavailability of Green suppliers (Expert Interviews).
4. Green products and materials can be more expensive (Varnäs *et al.* [9]).
5. Lack of coordination and cooperation between various supply chain stakeholders (Balasubramanian [1]).
6. Lack of regulations and minimum supplier commitment (Walker *et al.* [6]).
7. Lack of governmental support in terms of incentives and awards for implementing GSCM (Balasubramanian [1]).
8. Society is not aware of GSCM practices importance (Expert Interviews).
9. Lack of public awareness of the importance and benefits of sustainability hence lack of customer demand and pressure for sustainable projects and products (Balasubramanian [1]).
10. Companies' unwillingness to exchange information (Walker *et al.* [6]).
11. High initial cost (Balasubramanian [1]).
12. Lack of Government incentives or lower taxes (Expert Interviews).
13. Lack of environmental regulations and monitoring plans (Expert Interviews).

Internal barriers include the following:

1. Lack of organization's top and middle management support and lack of GSCM practices in firm's vision and mission (Balasubramanian [1]).
2. High initial cost (Walker *et al.* [6]).
3. Lack of experience as well as knowledge among the stakeholders, fear of complexity of GSCM and lack of CSR (Balasubramanian [1]).
4. Contractors follow the consultant's specifications so they do not intervene in the materials selection (Expert Interviews).
5. Lack of exchanging information (Balasubramanian [1]).
6. Resistance to changing traditional practices (Expert Interviews).



7. Lack of GSCM trainings and workshops that improves the employees' environmental performance (Balasubramanian [1]).
8. Lack of sustainability audits and certification (Balasubramanian [1]).
9. Lack of proper technologies for recycling the generated wastes such as construction and demolition wastes (Balasubramanian [1]).
10. Lack of knowledge and experience of stakeholders (Expert Interviews).

3 Methodology and implementation

This paper presents a study of implementing GSCM in the Egyptian construction firms as a sample of the application of GSCM in a developing country.

The steps of the methodology (Figure 1) include:

- 1) Conduct literature review to identify general requirements of GSCM, and the drivers and barriers of its application in construction companies.
- 2) Hold experts' interviews to amend the requirements and modify them to fit local construction companies in developing countries.
- 3) Develop a questionnaire to assess the status of applying GSCM in local construction organizations that includes GSCM drivers and barriers.
- 4) Conduct a case study to collect data from experts, based on the questionnaire, to compare the drivers and barriers in a local model vs. an international model and comment on the Environmental Law of Egypt as an example of the regulations in a developing country.
- 5) Analyze the gaps and provide recommendations.

Based on literature review and experts' interviews, GSCM practices, drivers and barriers were identified. Experts included university professors and managers of environmental department in construction firms. Most of the interview results recommended that GSCM can be implemented in terms of the firm's product lifecycle, operational lifecycle, and waste management. The identified barriers and drivers were categorized into external and internal. The identified GSCM practices, barriers, and drivers were then used to develop a questionnaire. Based on experts' recommendations, the questionnaire was divided into the previously recommended three main categories related to GSCM; each was subdivided into barriers and drivers. The questionnaire included questions about governmental environmental policies and regulations, ISO certification and market competitiveness, criteria of selecting suppliers or sub-contractors, environmental trainings offered by the firm or the government to the enhance the environmental awareness of the employees, the firm's environment department, availability of green suppliers in Egypt and worldwide, society and NGOs pressure and middles, top management support to purchase green materials, and the level of satisfaction of the GSCM implementation in the organizations. The responses of the questionnaire were used to assess the situation in Egypt and categorize the requirements of implementing GSCM.

Then, the questionnaire was used to conduct two case studies through interviews with two environmental experts and four key personnel in two different construction organizations (one local and one international) in Egypt. The responses of the questionnaire were used to identify the GSCM application

status of the local company and the international company. A comparison table was developed comparing the cases that included comments on the Egyptian Environmental Law. The results of the comparison are evaluated in the next step.

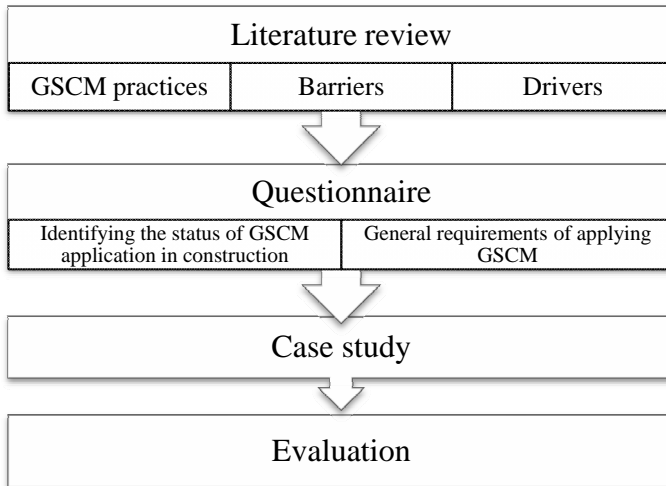


Figure 1: Methodology framework.

4 Case study

The case study consists of two construction firms one is local Egyptian firm and the other is an international model. The international firm has its sustainability and environmental standards but its environmental performance is affected by the Egyptian regulations and market. Both firms are similar in terms of number of projects, nature of projects, experience, number of suppliers, number of employees both are contracting firms working in the Middle East, Tables 1 through 3 include the results of the case study.

5 Discussion of the case study results

There are various drivers that encourage both the international and the local models to implement GSCM practices. An ISO 14001 certificate is required by some customers in the construction industry so market competitiveness makes both organizations keen to be ISO certified. This may not be applied to smaller firms as ISO statistics in 2011 show that the number of certificates for ISO 14000 family is 526 in Egypt, 2425 in the Middle East, and 1740 in Africa while it is 15231 in the UK and 106700 in Europe (ISO [2]). Customer demand makes both models conduct surveys to assess customer satisfaction of environmental performance. It is stated in the Egyptian Environmental Law that Egyptian Environmental Affairs Agency (EEAA) can prepare and supervise the implementation of environmental training programs; however this practice is not applied as the local model offers environmental trainings to the employees.

Table 1: Product lifecycle comparison.

Category	Local Model	International Model	Egyptian Environmental Law	
Product Life Cycle	Drivers	ISO 14001 Certified	ISO 14001 certified	Law does not require organizations to be ISO certified
		Local trainings exists	International training exists to enhance employees environmental performance	EEAA may prepare and supervise the implementation of a plan for environmental trainings (Article 5)
		-	CSR and company reputation	Citizens can report violations (Article 103)
		Conduct customer opinion survey for environmental aspects	Conduct customer opinion survey for environmental aspects	N/A
		Regulations to reduce pollution do exist	Regulations to reduce pollution do exist	Protection from air, water and land (Articles 19 to 68)
		-	Coordination with suppliers to develop sustainable products	Law does not mention the development of sustainable products
	Barriers	Lack of awareness in the company	Lack of society's awareness in Egypt	EEAA may provide educating programs for the public (Article 5)
		Lack of green expertise and developers	-	EEAA may prepare a list of expertise for environmental programs (Article 5)
		Lack of CSR	-	Citizens can report any violations (Article 103)
		Lack of government incentives	Lack of government incentives in Egypt	System of incentives does exist (Articles 17.18)

The Egyptian Environmental Law includes articles to protect the environment from pollution and firms that violate the law are subject to law enforcement. Regulations force both models to reduce the pollution and hazardous wastes generated from the industry however only disposal is required. The local model collects paper and liquids that can be recycled and sells it while the international model collects paper waste to be recycled in one of the Egyptian charity organizations as part of its corporate social responsibility activities. The society and NGOs' pressure is one of the drivers that encourages the international model implement GSCM and market for its sustainability achievements while lack of society awareness in Egypt is considered to be a barrier for the local company. In addition to the previous the barriers for both local and international models there exists the lack of regulations for recycling and remanufacturing of materials in Egypt hence a large amount of natural resources is wasted in addition to a lack in green suppliers. The EEAA provides no incentives although stated in the law.

6 Evaluation and recommendations

The implementation of GSCM in construction firms in Egypt amongst developing countries requires coordination between various parties namely; the



Table 2: Operational lifecycle comparison.

Category	Local model	International model	Egyptian environmental law	
Operational Life Cycle	Drivers	ISO 14001 certification	ISO 14001 certification	Law does not force organizations to be ISO certified
		-	Society and NGO pressure the organization to purchase green materials	Citizens and organizations has the right to report any violations to the law Article 103
		-	Middle and Top management support	N/A
		Local suppliers are preferable to reduce transportation costs	Local suppliers are preferable to reduce transportation costs	Law does not force organizations to purchase from local suppliers
		Remanufacture scrap metal	Use of reverse logistics	Reverse logistics is not mentioned in the Law
		-	Reduce cost by purchasing materials based on whole life basis value of money	N/A
	Barriers	-	CSR and company reputation	Citizens and organizations has the right to report any violations to the law Article 103
		Green suppliers are not available in Egypt	Green suppliers are not available in Egypt	-
		Lack of society awareness	Lack of society awareness in Egypt	EEAA may provide educating programs for the public Article 5
		Lack of top and middle management support	-	N/A
		Lack of government incentives	Lack of government incentives in Egypt	EEAA shall establish a system of incentives Ch. 4 Article 17,18
		-	-	-

government, project owners, consultants, contactors, manufacturers, suppliers, society and universities. This study was conducted comparing a local model to an international model working in Egypt. Future research should include more case studies considering variety in firms' sizes and private vs. public sectors. The Government should encourage the parties involved in the construction industry through incentives and subsidies systems and taxes reduction for firms that implement GSCM. It can establish projects to support C&D waste management by recycling and remanufacturing. These projects will provide job opportunities; reduce pollution as well as bringing profits to the parties involved. The government can decrease customs on imported green materials. The EEAA have to provide educating programs for the public and for students in schools consequently the society will become more aware of the environmental problems and use its right to report any violations. Monitoring of the GSCM

Table 3: Waste management comparison.

Category	Local Model	International Model	Egyptian Environmental Law	
Waste Management	Drivers	-	Citizens and organizations has the right to report any violations to the law (Article 103)	
		Paper waste is either sold or recycled	Paper waste is recycled	Recycling is included in the Law but not binding
		Regulations to dispose toxic wastes	Regulations to dispose toxic wastes	Management of hazardous wastes (Articles 29 to 33)
		Remanufacture scrap metal	Reverse logistics to remanufacture scrap metal	Recycling and remanufacturing are included in the law but not binding
		Regulations to dispose C&D wastes	Regulations to recycle C&D wastes	Recycling and remanufacturing is included in the law but not binding
	Barriers	Lack of regulations for recycling.	Lack of regulations for recycling in Egypt	Law includes recycling of materials but not binding
		Lack of waste management and recycling innovative technologies	Lack of waste management and recycling innovative technologies in Egypt	EEAA may prepare a list of expertise for the preparation and implementation of environmental programs (Article 5)
		Lack of society awareness	Lack of society awareness in Egypt	EEAA may provide educating programs for the public
Lack of government incentives		Lack of government incentives in Egypt	EEAA shall establish a system of incentives (Articles 17.18)	

implementation is essential and procedures should be taken against any violations such as penalties. Ranking of the contractors in Egypt should include environmental aspects. Owners of projects should include environmental aspects in the award of contracts in addition to the quality and cost. Manufacturers should seek innovative technologies to design and produce green materials. Consultants should choose green materials in the specifications of the projects. Contractors shall state sustainability and GSCM practices in their mission and vision, create a department for solving environmental issues, conduct environmental training programs for the employees, get ISO 14001, select suppliers based on their environmental performance, and monitor them. Suppliers should provide sustainable materials and manage and mitigate their environmental impacts. Society and NGOs should create pressure and report any violations. Universities should conduct research studies to provide guidance to construction firms. As a conclusion, GSCM can be implemented in developing countries through integration and coordination between various parties.

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