



TECHNOLOGIES FOR SUSTAINABLE LIFE (TSL)
– CONCISE MONOGRAPH SERIES

Green Supply Chain Management

Joseph Sarkis

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Series Editors' Preface

Technologies for Sustainable Life (TSL) – Concise Monograph Series

ASME's Technologies for Sustainable Life (TSL) is a series of concise and timely monographs exploring the interface between engineering and the environmental sustainability agenda. The series adopts a broad base examining fundamental principles and paradigms before a contextual exploration of ecosystems and resources, sustainable manufacturing, energy technology, environmental pollution and finally aspects of environmental governance.

Each monograph is written by leading experts in their field and examines the relationship and contributions of engineering to the topic of study. As a series, TSL addresses a long-awaited niche in engineering publishing, providing in-depth discussions of environmental significance set within a technology, economic and policy context.

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Author Biography

Joseph Sarkis is a Professor of Management within Worcester Polytechnic Institute's School of Business. He earned his Ph.D. from SUNY at Buffalo. He was also a faculty member at Clark University and the University of Texas at Arlington. His teaching and research interests include topics in Business and the Natural Environment, Operations, Logistics, Technology, Information and Supply Chain Management. He has also taught courses on topics in Sustainability, Business and the Natural Environment.

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He is editor of *Management Research Review*. He is editor of the social issues and sustainability department for *IEEE Transactions on Engineering Management*. He is a General Editor for the *Journal of Green Building*. Dr. Sarkis has served as Guest Editor of over a dozen special issues on Sustainability and Business topics in such journals as the *European Journal of Operational Research*, *Decision Sciences*, *Journal of Cleaner Production*, *Business Strategy and the Environment*, *International Journal of Operations and Production Management*, *International Journal of Production Economics*, *Greener Management International*, and *Information Systems Frontiers*. He also serves on the editorial boards for a broad variety of journals including sustainability, operations and supply chain management, technology management, production, and information systems journals.

He has served as a visiting scholar at various international locations including Cardiff University's BRASS center, the University of Oviedo in Spain, Hanken School of Economics in Helsinki, and in the EU Erasmus Mondus MESPOM program. He has also been a Sea-Sky Scholar at Dalian University of Technology in China. He is an AT&T Industrial Ecology Fellow.

Abstract

This monograph focuses on the issues facing sustainability in supply chains. Specifically it provides an overview of green supply chain management (GSCM) and the management of technology within this context. The topics include the operational and technological activities and characteristics of GSCM management. Organizational greening activities that play a role in GSCM operations are presented. The monograph also provides functional activities of the GSCM which include supplier management, internal operations management, logistics, and reverse logistics issues. Managerial considerations related to planning, justifying, and implementing GSCM and the respective technologies provide some insights into management decisions that will be faced in this environment. The references and bibliography provide a dozens of additional readings for those interested in this emergent and complex issue.

1. Introduction to GSCM and the technology perspective

Green Supply Chain Management (GSCM) has garnered significant attention as pressures for corporate environmental sustainability have increased. Instead of a sub-optimal focus only on internal organizational activities, products, and services, the focus has shifted to supply chains, extended producer responsibility, and cradle-to-cradle life cycle analysis, all of which are interrelated.

Even with these pressures organizations are still hesitant and/or uncertain on how to manage the complex environment afforded by GSCM. This monograph overviews GSCM from a more practical perspective with some theory thrown in to provide additional context. Utilizing previously published works by the author and some latest developments in practice and theory, the topics are brought together around a general framework of organizational and inter-organizational environmentally-oriented practices. Some of the most current thought on GSCM and future directions will also be included.

This monograph, given the theme of the ASME Sustainable Technologies for Life series, will incorporate significant discussion on technology and innovation. Huber (2005) defines technology as a body of knowledge, especially know-how, but also includes some theoretical know-why as well as know-what-for. Technology may be hard or soft. Hard technology is usually product oriented with significant tangibility. While softer technologies, within an organizational context, may be more policy, services or practices oriented.

Arguably, GSCM itself can be viewed as an organizational innovation and technology. GSCM components contain both soft and hard technology. Aspects of it may be softer and less tangible such as information and environmental management systems, while tangible technologies such as renewable energy technologies and transportation technologies may be durable and tangible.

GSCM as an organizational technology and innovation provide ample 'win-win' opportunities. Win-win opportunities provide organizational and supply chain on both economic and environmental dimensions. Theoretically, ecological modernization theory specifically stipulates that technology is a major driver of win-win opportunities at the organizational and supply chain level (Park et al., 2010; Zhu et al., 2011; Zhu et al., 2012; Sarkis and Cordeiro, 2012). Ecological modernization theory can be applied to nations and governments, as well as organizations and supply chains. At the policy level of analysis technology can help countries to decouple the relationship between economic growth from environmental degradation. In fact, the concepts of the green economy and green growth are dependent on

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environmental technologies. GSCM is part of the necessary policy tool set to help in this decoupling.

Thus, in our review and overview of the practical aspects of GSCM the particular technological focus will be on GSCM as an overall organizational innovation. We also identify various elements of GSCM that are either supported or utilize technology.

We introduce a variety of sections in this monograph. We first provide context and a bit of historical and background development to supply chain management and corporate environmental management (greening the corporation). This context provided in the next two sections provides an outline of the various complexities faced by managers, engineers, and organizations in managing the separate elements of GSCM. We then integrate the two contexts into the core focus of this monograph we define as GSCM. Major functional activities in GSCM, including supplier management, operations, logistics, and reverse logistics, are then overviewed. Given the many GSCM dimensions and activities, we only touch upon what we view are the more important topics facing organizations. Given the complexity of the technological, innovation, and organizational relationships that need to be managed, we present a number of cogent reasons on how organizations can make the 'business case' for GSCM in their organizations in a section defined as Management and Competitive issues facing GSCM. A broader theoretical perspective is also presented given further insights into understanding GSCM. We finally provide a conclusion that summarizes and presents some possible future concerns for further GSCM development and adoption amongst organizations and their supply chains.

2. Overview of supply and value chain management

The concept of the supply chain has been a relatively recent business topic, especially when compared to the broader history of industry and commerce. Yet, the actual practice of supply chain management has been occurring for many decades, if not centuries. Using the supply chain for competitive advantage can easily be traced to Henry Ford who vertically integrated his vendors and materials supply chains to more effectively and efficiently manage his operations. Thus, competitive advantages of the supply chain were noticed in the early stages of the US's rise to world prominence as an industrial and commercial power.

Since the vertical integration periods of Henry Ford recent efforts to decentralize and disaggregate the supply chain have occurred. Organizations have sought to outsource non-competitive processes and activities. Given these outsourcing pressures, supplier influence and importance is greater than ever before. Outsourcing reduces control over the supply chain. Part of this control is the limitations that some organizations have in managing their supply chain's corporate social and environmental responsibilities.

The globalization of the supply chain also has influenced how organizations manage their supply chains. Supply chain globalization requires organizations to consider both the cultures and policies of the source companies and their customers' situations. Organizations have to consider changing regulatory policies and norms throughout the world for thoughtful and competitive supply chains.

Taking a step back, we take a look at how supply chains have evolved. Michael Porter (Porter, 1985) provided one of the seminal studies that caused organizations and academics to pay greater attention to supply chain practices included the concept of the value chain. Value chains set the foundation for greater focus on integrated supply chain management and the broader perspective of its use as for strategic competitive advantage. The value chain concept has defined a number of core (primary) business activities and supporting activities that need to be managed to provide an organization with competitive advantage. The major core activities, which we can arguably be defined as the supply chain include Inbound Logistics, Operations, Outbound Logistics, Marketing and Sales, and Service. The support activities include Firm Infrastructure, Human Resource Management, Technology (especially information technology) and Procurement. Most of these activities were focused on a single organization. When the activities are tied to other organizations, whether they are suppliers or customers (buyers), then a supply chain or network is formed.

A definition of the supply chain from one of the most popular textbooks is: "The supply chain encompasses all activities associated with the flow and transformation of goods from raw materials (extraction), through the end

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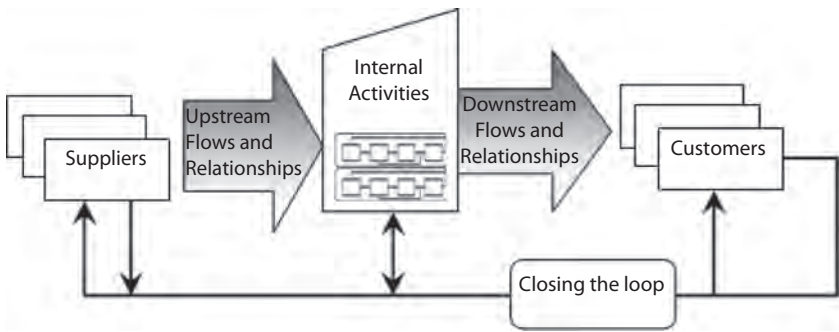


Figure 2-1 Generalized diagram of supply chain elements, flows and relationships.

user, as well as associated information flows. Material and information flow both up and down the supply chain.” (Handfield and Nichols, 1999).

Note that this traditional supply chain definition has a linear perspective. Advances that take into consideration closed loop aspects require explicit consideration of return processes. We can describe the elements of broader vision of supply chain as shown in Figure 2-1.

We have suppliers in the upstream portion of the supply chain, who also have suppliers, and so on. The central portion of the supply chain is composed of a number of organizational practices, many are defined by Porter’s value chain. Products and materials are then delivered to the buyer, and their customers. In a greener supply chain closing the supply chain loop is necessary bringing materials and other outflows back into the system, extending the useful life of materials and products.

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The technology, processes and activities for managing supply chain, based on value chain and closed loop (reverse logistics) perspectives are summarized in Table 2-1. Table 2-1 exemplifies the complexity associated with traditional supply chain management, without really focusing on greening issues, other than closing the loop. Each of these elements, and their supporting functions, will have greening implications. We will introduce a number of them later in this monograph. In the next section we give a brief overview of some corporate environmental management practices.

Table 2-1 Technology, activities and concerns facing core elements of the supply (value) chain

<p>Inbound Logistics</p> <ul style="list-style-type: none"> ✦ Transportation ✦ Material handling ✦ Material storage ✦ Communications ✦ Testing ✦ Information systems <p>Outbound Logistics</p> <ul style="list-style-type: none"> ✦ Transportation ✦ Material handling ✦ Packaging ✦ Communications ✦ Information systems <p>Reverse Logistics</p> <ul style="list-style-type: none"> ✦ Transportation ✦ Storage ✦ Collection ✦ Sorting ✦ Disassembly ✦ Repackaging 	<p>Operations</p> <ul style="list-style-type: none"> ✦ Process ✦ Materials ✦ Machine tools ✦ Material handling ✦ Packaging ✦ Maintenance ✦ Testing ✦ Building design & operation ✦ Information systems <p>Marketing & Sales</p> <ul style="list-style-type: none"> ✦ Media ✦ Audio/video ✦ Communications ✦ Information systems <p>Service</p> <ul style="list-style-type: none"> ✦ Testing ✦ Communications ✦ Information systems
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