



# Sustainable supply chain management: Review and research opportunities

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Extended producer responsibility;  
Emissions trading

**Abstract** Anthropogenic emissions likely pose serious threat to the stability of our environment; immediate actions are required to change the way the earth's resources are consumed. Among the many approaches to mitigation of environmental deterioration being considered, the processes for designing, sourcing, producing and distributing products in global markets play a central role. Considerable research effort is being devoted to understanding how organisational initiatives and government policies can be structured to facilitate incorporation of sustainability into design and management of entire supply chain. In this paper, we review the current state of academic research in sustainable supply chain management, and provide a discussion of future direction and research opportunities in this field. We develop an integrative framework summarising the existing literature under four broad categories: (i) strategic considerations; (ii) decisions at functional interfaces; (iii) regulation and government policies; and (iv) integrative models and decision support tools. We aim to provide managers and industry practitioners with a nuanced understanding of issues and trade-offs involved in making decisions related to sustainable supply chain management. We conclude the paper by discussing environmental initiatives in India and the relevance of sustainability discussions in the context of the Indian economy.

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## Introduction

A broad consensus has by now emerged that anthropogenic emissions pose serious threat to the stability of our environment, and that the resulting changes will affect our ecosystem by disrupting food and water supplies, submerging coastal wetlands, and causing severe weather patterns and species extinction. The global average temperature has been rising since the early 1900s, and has risen by more than 0.5 °C in the last 50 years alone, with an accompanying rise in global average sea levels and drop in Northern Hemisphere snow cover (IPCC, 2007a). Decades of careful data collection, analysis and projections by groups

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of scientists and researchers around the world have confirmed that the world faces severe changes with an expected 2–4 °C rise in global average temperature by the year 2100: 30–40% of the species could be extinct, close to a third of global coastal wetlands are in danger of being submerged, millions of people will likely face food and water shortages, and many densely populated areas of the world, including many parts of Asia, will face higher rates of morbidity and mortality from heat waves, floods and droughts (IPCC, 2007b).

A large part of the blame has been attributed to the six greenhouse gases (GHGs) that are known to trap heat into the earth's atmosphere and contribute to a rise in global temperature: primary ones being carbon dioxide, methane, and nitrous oxide. As measurements have shown, concentrations of GHGs in the earth's atmosphere have been relatively stable over the last 10,000 years (at between 250 and 300 parts per million). However, in the last 150 years or so—since the beginning of industrial revolution—concentrations of carbon dioxide in the atmosphere have shot up by more than 30% (from less than 300 ppm to close to 400 ppm), and concentrations of methane have almost doubled (IPCC, 2007a). Several large scale model projections have shown that a business-as-usual scenario, with no changes in our production methods and consumption habits, will lead to an imbalance in the ecosystem and damage the stability of our environment.

There is an obvious need for urgent action to change the way we consume the earth's resources. Among the many approaches to mitigation and adaptation being considered, the processes for designing, sourcing, producing and distributing products in global markets play a central role, as these activities account for a bulk of the resources consumed and the environmental impact. For example, in the United States, industrial activities account for about a third of fossil fuel related carbon dioxide emissions; another 40% are accounted for by transportation (EPA, 2007). Evidently, design and management of supply chain activities is a primary factor in promoting environmental sustainability.

In this paper, we review the current state of academic research in designing and managing sustainable supply chains, and provide a discussion of future directions and research opportunities in this rapidly evolving field. In Section 2, we provide a definition and description of Sustainable Supply Chain Management. In Section 3, we summarise and discuss existing classifications and reviews of research in this field, and describe how our perspective differs from those in the literature. Section 4 presents the bulk of recent research in this area that fits our integrative perspective, summarised under four broad categories: (i) Strategic considerations; (ii) Decisions at functional interfaces; (iii) Regulation and government policies; and (iv) Integrative models and decision support tools. We conclude in Section 5 with a discussion of some environmental initiatives in India and the relevance of sustainability discussions in the context of the Indian economy.

## Sustainable Supply Chain Management (SSCM)

We define Sustainable Supply Chain Management (SSCM) as a set of managerial practices that include all of the following:

- Environmental impact as an imperative;
- Consideration of all stages across the entire value chain for each product; and
- A multi-disciplinary perspective, encompassing the entire product life-cycle.

This definition implies a few broad themes in our perspective on environmental sustainability. First, firms must view environmental impact of their activities as an integral part of decision-making, rather than as a constraint imposed by government regulation or social pressure, or as a fad to exploit by appearing to be “green”. Second, firms must pay attention to environmental impact across the entire value chain, including those of suppliers, distributors, partners and customers. Third, firms' view of sustainability must transcend a narrow functional perspective and encompass a broader view that integrates issues, problems and solutions across functional boundaries.

In keeping with this definition, our review of the literature on SSCM adopts a firm perspective, rather than societal or policy-makers' perspective, and focuses on organisational decisions related to the entire product life-cycle that involves design, production, distribution, consumer use, post-use recovery and reuse. We do not limit ourselves to literature in any one academic discipline; rather, we focus on interactions across functional areas including corporate strategy, product design, production and inventory management, marketing and distribution, and, regulatory compliance.

The paper is intended to provide managers and industry practitioners with a nuanced understanding of issues and trade-offs involved in making decisions related to SSCM. The paper is also intended to provide management researchers with a summary of the current state of the art in SSCM research, and a roadmap for future research directions.

## SSCM research: reviews and classification

Several excellent reviews have been written over the years that examine various aspects of SSCM-related research. While these reviews adopt different perspectives from ours, readers interested in exploring a particular aspect of SSCM would find them useful. For instance, many of the existing reviews explore the SSCM literature for implications of environmental concerns on firm's individual functions involving activities such as product design, production planning, or inventory management. On the contrary, we examine the existing studies from a value-chain perspective, and discuss environmental concerns in managerial decisions across functions. Moreover, most of the existing reviews cover literature that is, in some cases, over a decade old. Our review focuses on more recent research in this fast changing and growing field.

Early research efforts in SSCM were largely devoted to understanding the technical and operational considerations inherent in collecting, testing, sorting, and remanufacturing of returned products. Research in this domain can broadly be classified under the following headings: (i) Production planning, scheduling and control; (ii) Inventory

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