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Developing Strategies for Green Supply Chain Management

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The field of supply chain management has more recently directed its attention to the role of the supply chain in both (a) impacts to the natural environment and (b) the generation of environmental performance change. This shift in our expectations for the supply chain has arisen from growing social pressure, legislative changes around packaging and end-of-life goods, identified supply chain risks, and increasing use of environmental requirements being cascaded from customers to suppliers. Several years of research into the occurrence of green-supply-chain-management activity (GSCM) has led to a general acceptance of its relevance and purpose. At this point in the field's development, however, there is substantial scope for improving our understanding of potential *strategies* of GSCM rather than just a series of related greening practices without a definite purpose. Owing to increasing and rapid developments in the field of green supply chain management, we describe an evolving set of distinct supply chain strategies in support of this type of activity and propose some directions for the future. In the manner of Fisher (1997)—what might be the most appropriate GSCM strategy for a particular product, process, or industry context?

Background

An increasing number of organizations have introduced 'greening' requirements to both upstream and downstream supply chain activity—purchasing clauses, targets, practices, and technologies. Automotive firms frequently require suppliers to certify to ISO 14001 (Toyota and Ford). Starbucks Coffee as well as Ben and Jerry's require raw material suppliers to meet guidelines for sustainable farming. Other organizations have introduced purchasing requirements that ensure suppliers avoid specific materials such as chemicals that may be deemed hazardous to the environment (DuPont, Seventh Generation, and organic supply chains). An increasing number of supply chains invest in recycling systems intended to retrieve waste or used product from customers (Kodak, Hewlett Packard, and Fuji-Xerox).

Much is still unknown, however, regarding the management efficacy and likely costs to the supply chain from altering its traditional focus of cost, quality, and service to include environmental performance. The extent of the supply chain's legitimate control over such environmentally focused activity is an area of active debate. For example, the organization that claims 'carbon neutrality' for its product supply chain may be unlikely to effectively monitor or control the carbon generating activities of upstream suppliers. The supply chain is comprised of a series of entities, activities, customers, cultures, and goals that frequently fail to find alignment on anything but the most basic of concerns. Very few activities in a supply chain are likely to succeed if they are not accompanied by some form of relationship control that will (a) justify the level of investment for both parties and (b) guarantee its implementation.

The explosion of GSCM activity in the practical realm has led to an increasing body of empirical work regarding both external influences leading to the uptake of green supply chain management practices, and their impact on firm performance. Investigation in this area has generally fallen into four main categories:

- Use of compliance-based strategies that support the cascading of basic environmental requirements generically across all suppliers (Melnyk, Sroufe, & Calantone, 2003; King, Lenox, & Terlaak, 2005)
- Aligning supply chain goals for both efficiency and pollution-reduction (Corbett & Klassen, 2006; Rothenberg, Pil, & Maxwell, 2001)
- Transfer of environmentally specific innovations or technologies from customers to suppliers (Geffen & Rothenberg, 2000; Klassen & Vachon, 2003)
- Collaboration or competition between firms to develop re-manufacturing or closed-loop recycling systems (Guide & Van Wassenhove, 2002; Pagell, Wu, & Murthy, 2007).

Relevance of the Supply Chain Relationship

Supply chains achieve performance improvements or resource development through either building-specific capabilities over time or by looking to the supply relationships to gain access to new resources (Eisenhardt & Schoonhoven, 1996). This may occur through either: (a) coercive pressure—pass responsibility upstream or introduce contractual clauses for suppliers (Pagell et al, 2007; Zhu & Sarkis, 2007); or (b) collaboration—utilize social capital within existing relationships to develop new competencies (Liker & Choi, 2004; Paulraj, Lado, & Chen, 2008). With regard to environmental performance management, coercive pressure provides a minimum level of compliance to requirements amongst suppliers but tends to be limited in its capacity to encourage advanced performance outcomes such as new knowledge or innovation. Collaboration on environmental performance issues tends to increase the range and complexity of possible outcomes—such as new products or technologies—but requires a far greater level of involvement for customers and suppliers.

Several modes of interaction between a customer and its suppliers are available with the express purpose of altering or improving aspects of supply chain performance. These are essentially competitive pressure (rely on the market); evaluation or certification schemes (rely on a third party); incentives; and direct involvement (Krause et al, 2000; Modi & Mabert, 2007). All modes are possible—though with different outcomes—regardless of whether the climate of a relationship is more coercive or collaborative. We draw on the relationship implications of supply chain performance improvement as well as the possible pathways to development of supply chain resources to establish a typology of strategies for GSCM. We move away from the traditional discussion of GSCM strategies built around reputational or societal pressures and instead build a typology based in more traditional supply chain management theories to move the GSCM field forward.

Strategies of Green Supply Chain Management

Risk-based Strategies

The simplest strategy of GSCM with regard to inter-organizational investment resource development is one of risk minimization. Firms adopting this strategy are proposed to do so in response ostensibly to stakeholder requirements. Such a strategy is ideal for the organization that retains minimal internal environmental management resources or has only recently begun to consider the introduction of a supply chain greening program. It is based on minimal inter-organizational engagement. Such efforts might involve the inclusion of basic clauses in purchasing contracts for suppliers to meet all relevant regulatory requirements. Most frequently used with this approach is the cascading of an established international standard such as ISO 14001 (King, Lenox, & Terlaak, 2005). The use of an existing performance standard, an approach used initially by the Ford Motor Company with its suppliers and now more frequently by other organizations for their supply chains, offers: (a) established environmental performance benefits (Melnyk, Sroufe, & Calantone, 2003), (b) third party or arms-length management of performance, and (c) a system recognized globally by other organizations. This third aspect improves the efficacy of uptake by suppliers because the system is recognized by the market and other industry members, reducing the ambiguity of desired performance levels and minimizing the need for customer involvement. From the perspective of competitive advantage, however, the benefits are limited because of the ease of implementation, a lack of uniqueness, and a growing use by other supply chains. A similar approach to basic certification schemes is the use of broad statements within purchasing guidance or principles to include 'supplier activities' among the organization's environmental responsibilities. Such systems based on risk minimization only and managed in a climate of low relational investment only guarantee supply chain compliance with local or national regulations. The end result being that risk can be minimized and reputation enhancement is possible, but no additional innovation or complementary economic benefits are likely.

Efficiency-based Strategies

A more complex and developing strategy in recent years has been the 'eco-efficiency' or 'lean-and-green' approach to GSCM. This type of strategy derives environmental performance benefits for the supply chain beyond mere regulatory compliance through the requirement for suppliers to meet operations-based efficiency targets. Much of the environmental performance benefit arises from specific manufacturing practices that have been found to provide secondary environmental performance benefits. The point of departure for the efficiency-based strategy from the risk-based strategy is the availability of dual economic and environmental performance benefits to the supply chain and the requirement for higher levels of engagement between customers and suppliers. The efficiency-based strategy ties environmental performance to operational processes in the supply chain, and this strategy allows the extension of performance

requirements into the supply chain that maximize economic performance and provide secondary environmental performance benefits through waste and resource use reductions. It requires more comprehensive and supply chain specific performance specifications than the simpler risk-based strategy. It also requires a higher level of involvement between supply chain partners arising from the use of more complex inter-firm performance requirements. Using this strategy to facilitate greater efficiency in the supply chain does not require the development of co-specialized resources specific to environmental performance. The necessity for collaboration on efficiency, however, provides a facilitating role for context-specific, complex problems such as waste reduction and recycling (Geffen & Rothenberg, 2000; Klassen & Vachon, 2003). The strategy can provide a cost-reduction advantage to the supply chain and readily fits with pre-existing organizational goals of optimization. But the efficiency-based supply chain strategy does not allow for more knowledge-intensive environmental management activities such as product design, material substitution, or innovation. Product recalls because of a poor choice of low-cost but hazardous materials represent the inherent risk in focusing only on efficiency in the supply chain. The efficiency-based strategy is considered technically weak but more socially complex than the risk-based strategy.

Innovation-based Strategies

The innovation-based green supply chain management strategy is distinct from the efficiency-based approach because of its use of a supply chain environmental performance strategy that is more *environmentally specific*. Organizations are increasingly aware of the potential for narrow purchasing policies to in-source components or services from suppliers that may be legally non-compliant with environmental regulations or who themselves procure goods in an environmentally irresponsible way (Bowen et al, 2001). Some organizations have begun to guarantee more comprehensive product life-cycle considerations for consumers of their products. Once a supply chain begins to consider specialized processes, technologies, or complex performance standards for suppliers such as chemical avoidance, the level of knowledge exchange and relational investment begins to change. Moving from an efficiency-based GSCM strategy to a greater level of innovation or integration of environmental performance in supply chain and product design requires specialized environmental resources (Lenox & King, 2004). Keeping up-to-date with environmental legislation changes and training suppliers in environmentally relevant process changes requires more dedicated environmental resources, specialized personnel, and design. The development of such resources provides the conditions for an organization to shift from an efficiency-based to an innovation-based GSCM strategy. For products, the resources developed could be used to incorporate innovative environmental planning into specific product designs, characteristics, functionality, or life-cycle related activities (e.g., service, repair, and recycling). At the process level they could be deployed to develop environmentally robust methods and systems for the production, distribution, and use of products.

Closed-loop Strategies

Closed-loop strategies are a more recent type of GSCM strategy and represent the most complex and collaborative form of this type of activity. Often referred to in its simplest form as 'reverse logistics,' closing the loop involves the capture and recovery of materials for either re-manufacture (high-value) or recycling (low value) (Kocabasoglou et al, 2007). These materials can arise during production, as returned goods, post-use, and at end-of-life. The closed-loop strategy ties or integrates environmental performance to the whole supply chain. Very few examples of coordinated recycling or closed-loop activity in the supply chain currently exist however. Prominent examples include Kodak's return and re-manufacture of its disposable cameras, Hewlett Packard's retrieval of used printer cartridges, and BMW's end-of-life vehicle requirements for suppliers (Guide et al, 2002). The motivation for a closed-loop strategy remains low for basic reasons of poor and distributed control over the reverse supply chain, lack of available infrastructure, and the inability of supply chains to believe that such activity is economically viable. Designing and successfully using a closed-loop strategy presents one of the most complex endeavours for a single organization to undertake within its supply chain (Richey et al, 2005). In its simplest form, 'closing the loop' may involve product take-back and reverse logistics implemented only in the retail portion of the supply chain. In more complex 'closed-loop' systems, used or obsolete products and waste are taken back by the producer and remanufactured or recycled rather than being disposed of to landfill. The closed-loop strategy, however, represents an approach that seamlessly integrates issues of economic, operational, and environmental performance. Organizations considering implementation of a closed loop supply chain require high levels of control over the capture and return of used materials. Goods need to be managed for quality considerations and aggregation of collection and sorting activities allows for the creation of economies of scale. Such a high level of integration, coordination across partners, and socially complex knowledge requires years of development effort. Socially complex, collaborative relationships provide the basic foundation for a closed-loop supply chain strategy.

Directions for Future Research

There are many issues that require further scholarly research, which needs to be of 'best practice' case studies, and larger field studies that map the field and its progress. We also need to extend existing theories and principles of competitive advantage, operations management/SCM, resource-based view of the firm and others, to fully take account of mature GSCM practices and their integra-

tion into the mainstream of managerial work. Some suggested research areas and issues follow.

As raw material costs increase and environmental protection legislation becomes increasingly stringent, a focus on one firm's green operational excellence is becoming the norm in organizations. To attain even greater cost savings from waste reduction, meet comprehensive social and environmental responsibility targets and find new products with smaller ecological footprints, firms are now extending their goals for environmental performance into their suppliers' operations. This type of activity is an effective mechanism for firms to improve their record on corporate social responsibility, lower reputational risks, reduce wastes, and improve supply chain response-time to new environmental regulations.

As possible GSCM strategies become more complex and involve greater levels of relationship investment, their potential for competitive advantage also increases. Several supply chains have already developed systems of green supply chain management that may be many years ahead of or perhaps entirely out of reach for other supply chains (i.e., Hewlett Packard, Toyota, and Ben and Jerry's ice-cream). Other supply chains may only require the addition of environmental performance clauses into purchasing activities to adapt their supply chain to changing industry norms. More complex types of green supply chain strategy, however, offer increasing levels of economic, operational, and environmental performance.

At the supply chain level, organizations that involve suppliers and third parties in the greening process early—and well in advance of competitors—start a development path that may provide a *sustained* competitive advantage that lasts well into the future. For example, selecting and developing suppliers who retain unique capabilities in product take-back or re-processing or who exhibit high levels of environmental performance can provide a first-mover competitive advantage. Early selection of suppliers that are capable of delivering environmentally focused performance requirements will likely secure a pool of suppliers unavailable to other supply chains providing exclusive access to limited resources.

Firms wishing to rapidly release environmentally themed products and services, or make claims to such endeavours, cannot bypass the earlier phases of supply chain strategy development. Supply chain strategies that are designed for resource use efficiency and capture of all waste or by-products through the product life-cycle provide not just high levels of environmental performance but also the capacity to withstand approaching resource scarcity or legislative changes that affect and often re-define industries.

References

Bowen, F., Cousins, P., Lamming, R., & Faruk, A. (2001a). The role of supply management capabilities in green supply. *Production and Operations Management, 10*(2), 174-189.

Corbett & Klassen. (2006). Extending the horizons: Environmental excellence as key to improving operations. *Manufacturing and Service Operations Management, 8*(1), 5–22.

Eisenhardt, K., & Schoonhoven, C. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *Organization Science, 7*(2), 136–150.

Fisher, M. (1997). What is the right supply chain for your product? *Harvard Business Review*, March-April, 105-116.

Geffen, C., & Rothenberg, S. (2000). Suppliers and environmental innovation: The automotive paint process. International *Journal of Operations and Production Management, 20*(2), 166-186.

Guide, D., & Van Wassenhove, L. (2002). The reverse supply chain. *Harvard Business Review, 80*(2), 25-26.

King, A., Lenox, M., & Terlaak, A. (2005). The strategic use of decentralized institutions, Exploring certification with the ISO14001 management standard. *Academy of Management Journal, 48*(6), 1091-1106.

Klassen, R., & Vachon, S. (2003). Collaboration and evaluation in the supply chain: The impact on plant-level environmental investment. *Production and Operations Management, 12*(3), 336-352.

Kocabasoglu, C., Prahinski, C., & Klassen, R. (2007). Linking forward and reverse supply chain investments: The role of business uncertainty. *Journal of Operations Management, 25*(6), 1141-1160.

Krause, D., Scannell, T., & Calantone, R. (2000). A structural analysis of the effectiveness of buying firms' strategies to improve supplier performance. *Decision Sciences, 31*(1), 33-55.

Lenox, M., & King, A. (2004). Prospects for developing absorptive capacity through internal information provision. *Strategic Management Journal, 25*, 331-345.

Liker, J., & Choi, T. (2004). Building deep supplier relationships. *Harvard Business Review*, December.

Melnyk S., Sroufe R., & Calantone, R. (2003). Assessing the impact of environmental management systems on corporate and environmental performance. *Journal of Operations Management, 21*(3), 329-351.

Modi, S., & Mabert, V. (2007). Supplier development: Improving supplier performance through knowledge transfer. *Journal of Operations Management, 25*(1), 42-64.

Pagell, M., Wu, Z., & Murthy, N. (2007). The supply chain implications of recycling. *Business Horizon, 50*, 133-143.

Paulraj A., Lado, A., & Chen, I. (2008). Inter-organizational communication as a relational competency: Antecedents and performance outcomes in collaborative buyer–supplier relationships. *Journal of Operations Management, 26*, 45–64.

Richey, R., Chen, H., Genchev, S., & Daugherty, P. (2005). Developing effective reverse logistics programs. *Industrial Marketing Management, 34*(8), 830-840.

Rothenberg, S., Pil, F., & Maxwell, J. (2001). Lean, green and the quest for superior environmental performance. *Production and Operations Management, 10*(3), 228-243.

Zhu, Q., & Sarkis, J. (2007). The moderating effects of institutional pressures on emergent green supply chain practices and performance. *International Journal of Production Research, 45*(18-19), 4333–4355.

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