



# Building sustainability in logistics operations: a research agenda

Building  
sustainability: a  
research agenda

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## Abstract

**Purpose** – The purpose of this study is to examine the current state of sustainability efforts within the field of supply chain management, more specifically supply chain logistics operations, and to identify opportunities and provide recommendations for firms to follow sustainable operations. This study also aims to stimulate further research within the area of sustainable logistics operations.

**Design/methodology/approach** – The reasons why it is important to implement sustainability into supply chain operations is discussed. Based on a review of the extant literature, various areas within the logistics function where sustainability can be implemented are then presented. Some short-term and long-term recommendations for the successful implementation of sustainability in the logistics function of supply chains are provided.

**Findings** – There has been very little work done to understand the role and importance of logistics in an organization's quest towards sustainability. For firms to implement a sustainability strategy in their supply chain operations, the logistics function needs to play a prominent role because of the magnitude of costs involved and the opportunity to identify and eliminate inefficiencies and reduce the carbon footprint.

**Practical implications** – Firms in their quest for sustainable logistics operations must start early and start simple. A top management commitment is required for such efforts to be successful. Also, firms need to be able to visualize and map out their supply chains and benchmark their sustainability efforts with other firms in their industry.

**Social implications** – Firms need to follow sustainable practices in their overall operations and in their logistics operations in particular because not only does it have financial and other intangible benefits, but it is also the right thing to do. Firms have a great social responsibility especially with respect to use of non-renewable sources of energy and materials and also with respect to how their products are used and handled once they reach the end of their life cycles.

**Originality/value** – This paper is the first of its kind which examines the state of sustainability within the field of supply chain logistics operations and identifies areas and sets the agenda for future research in this field.

**Keywords** Sustainability, Logistics, Green, Transportation, Sustainable development, Supply chain management

**Paper type** Research paper

An important challenge organizations need to overcome has to do with how they perceive sustainability. They might not say this, but most firms act as if sustainability is about being less bad [...] people don't get excited about incremental changes [...] They need a more ambitious vision [...] A cool part of sustainability work is uncovering the assumptions that lead people to do things in a way that's out of touch with the company's larger reality [...] (Prokesch, 2010).



All authors contributed equally to the preparation and submission of this paper and are listed in alphabetical order.

## Introduction

The focus of corporate strategy has traditionally been about increasing the bottom line through cost reduction and increased sales. However, growing concerns over issues such as the limitation of resources, global warming, greenhouse gases (GHGs), and consumer health have increased the urgency for firms to incorporate sustainability into their strategies (Lee, 2010). With the development of the internet and 24-hour news, every company is constantly under the watchful eye of the public. Unsustainable practices hidden in the supply chain has the potential to become public information extremely quickly, leaving a company's brand value damaged and shareholders displeased. This is no more evident than the effect that the recent oil spill off of the US Gulf Coast had on the stock value of British Petroleum (Moss Kanter, 2010; Gross, 2010), the severe fines imposed on Shenzhen Energy Group after an ocean tanker transporting coal struck the Great Barrier Reef (Huang, 2010), and the consumer boycotts that threatened Nike after the public was made aware of "sweatshops" (Kenyon *et al.*, 2000).

With the rise of today's "conscious consumer", adding sustainability into the corporate strategy has become about meeting the expectations of investors while taking into account the long-term impact that operations have on the community and environment (Prokesch, 2010). A focus on supply chains is a step towards the broader adoption and development of sustainability, since the supply chain considers the product from initial processing of raw materials to delivery to the customer (Seuring *et al.*, 2008; Linton *et al.*, 2007). Since supply chain managers are engaged in every facet of the business process including logistics, strategic planning, information services, marketing and sales, and finance, each manager is in an ideal position to carry out sustainability initiatives (Sarkis, 1998). For supply chain managers, it is important to understand that day-to-day decisions have the potential to affect millions of stakeholders either positively or negatively (Murphy and Poist, 2003). If a decision is determined to have negative impacts at any point in the future, then it is not sustainable and not worth the risks associated. Though adding sustainability throughout the organization takes creativity, many firms have learned how to use it to differentiate themselves from their competitors, reduce costs, and improve services to their customers (Gold and Seuring, 2011; Pedersen, 2009). The interaction between sustainability and supply chains is the critical next step from recent examinations of operations and the environment (Corbett and Kleindorfer, 2003) and operations and sustainability (Kleindorfer *et al.*, 2005).

However, although many papers have focused on the idea of sustainability within the supply chain context (refer Seuring and Müller, 2008; Srivastava, 2007 for review), there is very little work done to understand the role and importance of logistics in an organization's quest towards sustainability. A logistics operation represents the integrated management of all the activities required to move products through the supply chain and subsequently, the logistic cost can be defined as "the monetary expression of all kinds of consumed labors in the course of product displacement" (BinA and Chaoyuan, 2005). For most firms, logistics costs is substantial and ranks second only to the cost of goods sold. According to the International Monetary Fund (IMF), logistics costs average about 12 percent of the world's gross domestic product each year (Ballou, 2004). As for the impact that logistics has on the environment, according to the Council of Supply Chain Management Professionals, logistics can produce up to 75 percent of a company's carbon footprint (The Council of Supply Chain Management Professionals, 2008). The combination of monetary cost and environmental

impact that logistics contributes to operations makes it a key area and there exists a need to explore opportunities to strengthen logistics and make it more efficient. Addressing this need is central to the research agenda of this study where we focus our attention on the area of logistics in the supply chain.

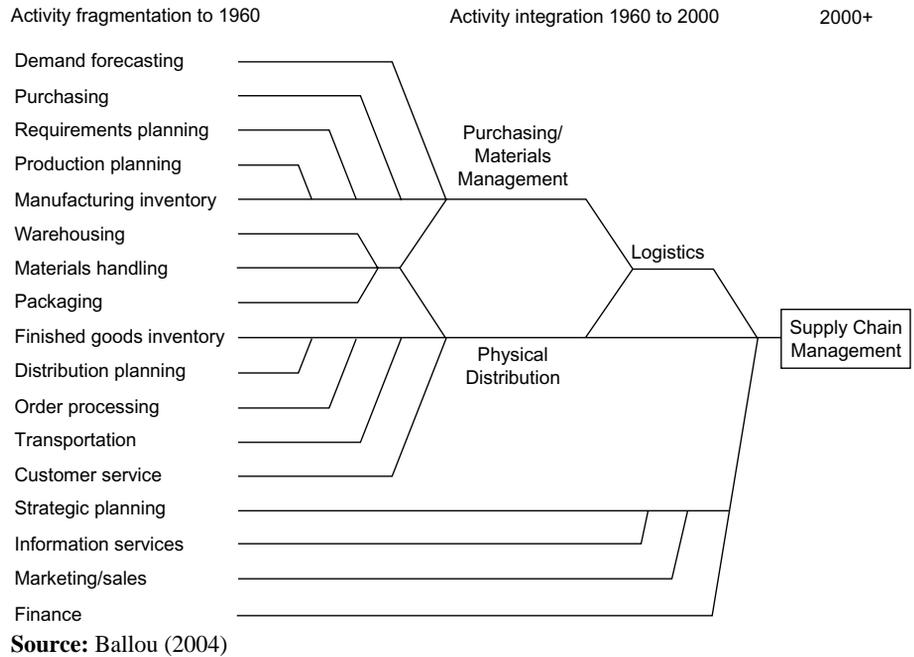
Specifically, we posit that there are numerous areas throughout the firm's logistics operations where sustainability can be implemented. We break down various areas in a firm's logistics function into the supply chain, value adding chain, distribution chain, and the reverse logistics chain. For each of the logistic functions, we identify opportunities for introducing and continuing sustainable operations. Also in this study, after providing examples of today's leading firms and how they define sustainability, we take a more detailed look at why all firms must begin implementing these practices immediately. We make the case that a number of factors will force firms into making changes to their logistics strategies. Every logistics manager needs to understand the relevance of each factor with his/her firm's logistics functions and start incorporating the ideal practices to achieve sustainability in the firm's operations. With multiple examples of firms performing at both first-class and below standard, we present areas within the logistics function where sustainability can be implemented, including both short- and long-term recommendations.

The remainder of the paper is organized as follows. First, we discuss the reasons why it is important to implement sustainability into the supply chain operations. The various areas within the logistics function where sustainability can be implemented are then presented. Finally, we provide some short- and long-term recommendations for the successful implementation of sustainability in logistics function of the supply chains.

### **Why the logistics function need to implement sustainability?**

Logistics involves "the activities to obtain incoming materials and distribute finished products to the proper place, at the desired time, and in the optimal quantities" (Markley and Davis, 2007, p. 767). Specifically, the components of a typical logistics system are: customer service, demand forecasting, distribution communications, inventory control, material handling, order processing, parts and service support, plant and warehouse site selection, purchasing, packaging, return handling, salvage and scrap disposal, traffic and transportation, and warehousing and storage (Figure 1). The process can extend from the raw material source through production and distribution to the point of consumption and the associated reverse logistics. Firms work with its trading partners (suppliers, shippers, distributors and customers) to improve their logistics activities and hence, greatly improve business performance (Sandberg and Abrahamsson, 2011) and reduce the logistics cost (Baykasoglu and Kaplanoglu, 2007). Logistics cost can be calculated as the sum of manpower and material resources that can exist in every stage of material movement such as packaging, loading, unloading, transportation, storage, processing in circulation and logistics information (Ballou, 2004).

For firms to implement a sustainability strategy in their supply chain operations, the logistics function needs to play a prominent role (Mollenkopf *et al.*, 2010; Goldsby and Stank, 2000). An interesting example is the logistics firms of Europe's chemical industry. Few of the initiatives that managers of these logistics firms have implemented are – full asset utilization, increase of unit size to small lots to full loads, cost-to-serve



**Figure 1.**  
Evolution of logistics  
toward supply chain

reduction and elimination of waste (Young, 2009). Such actions along with enhanced integration of various supply chain components and conformance to social systems and ethics surrounding the workforce based on quality and working conditions; have contributed to sustainable logistics and helped firms reduce their carbon footprint (Young, 2009). Wilson (2010) points out that enhanced fleet tire management for the US dairy and ice cream delivery trucks would not just reduce manufacturing cost and improve performance but can be an important step towards a sustainable logistics program. Byrne (2007, p. 22) identify sustainable physical asset management as the topmost priority for supply chain managers that could “minimize or eliminate energy-intensive storage, reduce travel times, and increase truckload utilization”.

Extant literature on logistics and supply chains also stress the importance of sustainability (Carter and Rogers, 2008) and energy efficiency (Halldórsson and Kovács, 2010). Abukhader and Jönson (2004) conducted a detailed literature review on environmental issues in logistics and observed weak ties in knowledge about implementation between the logistics and the environment discipline. In a research note, Halldórsson and Kovács (2010) point out that it needs considerable rethinking on the operational level to consider aspects of energy efficiency, which have been largely neglected in the logistics and the supply chain literature. In a 2008 survey of CEOs of large 3PL firms, five most important reasons for establishing their firms’ sustainability programs identified are – desire to do the right thing, pressure from customers, desire to enhance company image, desire to attract green customers and competitive pressures (Lieb and Lieb, 2010). If this is not reason enough to implement sustainability, we discuss some additional reasons next.

### *Brand value*

On April 3, 2010, a Chinese bulk carrier owned by Shenzhen Energy Group, a subsidiary of China's state-owned China Ocean Shipping Company, was transporting coal when it struck the Great Barrier Reef, spilling nearly two tons of heavy fuel oil into the water. Even worse, the out of control ship cut a two-mile gash into the coral causing damages that will not be corrected for decades. Investigators believed that the captains were trying to utilize an illegal short cut which would significantly cut down on transportation time. For their actions, two of the captains have been arrested and face multiple fines while Shenzhen Energy Group faces fines and costs of up to \$23 million dollars (Glionna, 2010).

Logistics horror stories such as this have the potential to not only damage a company through fines, but also their brand value. A company's brand value consists of intangible assets such as reputation and customer loyalty. Recently, all firms are constantly under the eye of the public, with access to 24-hour news programs and social networks developed over the internet. Unsustainable practices hidden in the supply chain has the potential to become public information very easily and quickly. This is no more evident than in 1999 as Nike faced media exposure and consumer boycotts over the "unethical" treatment of workers in "sweatshops". In a matter of days, Nike's brand value dropped from \$8 billion to \$7.6 billion and continued the slide for months (Preuss, 2001). Thus, firms who fail to formally implement sustainability and the steps to properly enforce it, ultimately put shareholder value at risk.

Conversely, a "green" company image can increase product sales. A study of *Fortune* 100 firms across several industries finds that almost 60 percent of firms adopt sustainable practices to strengthen brand names or differentiate their products to their consumers (Mahler, 2007). For consumers, although price and quality are still paramount, convenience has been edged out by more socially relevant attributes such as energy efficiency and health benefits. This effect has given way to the term "conscious consumer" who expects firms to do more than make eco-friendly claims and demand transparency and accountability across every level of business practice (Pepper *et al.*, 2009; Jones *et al.*, 2005). An example in hand is Chipotle Mexican Grill whose history of sustainable procurement ensures its credibility among its loyal customers. Chipotle's logistics managers work hard to achieve the goals of company's "Food with Integrity" campaign, which pledges the brand's practices of sourcing sustainable ingredients for its supply chain (Brandau, 2010).

### *Misuse of resources*

Without implementing sustainability into the global supply chain, firms risk misusing precious resources, most notably for logistics managers, gas and oil. In July of 2008, the price of a barrel of oil peaked at \$147.30 (Read, 2008). The soaring price caused transportation costs to increase dramatically around the globe since fuel costs went from making up 20 percent of total transportation to making up roughly 50 percent of total trans ocean shipping by 2008 (Pescatori and Mowry, 2008). The surge in oil prices as well as other commodities in 2008 forced many firms into corporate sustainability initiatives to reduce waste. Xerox, who lists fuel efficiency as one of its biggest challenges (nearly 60 percent of operating cost of Xerox's Canadian logistics operations was attributed to fuel consumption in 2006) implemented lean Six Sigma initiatives and replaced larger vehicles with smaller, fuel efficient vehicles without sacrificing cargo space or any other

business requirements (Dutton, 2009). In 2008, Kraft Foods Inc. worked closely with EPA's SmartWay Transport Partnership program and optimized their routing and internal network, consolidated distribution and reduced multiple stops. Such initiatives, coupled with other energy conservation measures, resulted in a 7 percent improvement in miles per gallon for the company when compared to 2003 Figures (Dutton, 2009). These initiatives should be pursued aggressively because within the context of sustainability and for a non-renewable resource such as fuel, the total cost of oil consumed in producing a product or service should always be under control (Abdel Sabour, 2005). Hence, the reduction in energy inputs (or increase in fuel prices) is offset by faster improvement in energy-related technology or continuous process reengineering projects (Smulders and De Nooij, 2003). Firms need to support these focused energy projects even when fuel prices declines, since they will not only realize a savings in resources but also achieve a smaller carbon footprint for the organization's ecosystem (Bellona, 2009).

#### *Government intervention*

Although there is a clear trend for governments to create policy guidelines to control pollutants, much of today's legislation is market specific and focuses on waste disposal and private cars (EPA, 2010). For example, the European Union has developed strict environmental regulations to prevent waste from end-of-life vehicles and promote collection, reuse, and recycling of their components to protect the environment (EUROPA, 2010). Similarly, multiple countries have enacted policies to control the waste of high-tech products and hazardous materials such as batteries (UNEP, 2010). While there are increasingly strict regulations being applied to air transportation such as noise restrictions and emissions standards, the degree of control over trucking, rail, and maritime modes is significantly less. Mounting pressures from consumers worried about health issues and global warming, however, are demanding that their political representatives do more to curb harmful carbon emissions. The legislation that is beginning to be negotiated certainly has the potential to affect all modes of transportation (Kainuma and Tawara, 2006).

Most logistics managers do not think carbon emission and other logistics regulations is a matter of "if", but a matter of "when". Thus, it is up to top management to determine if they want to implement sustainability throughout their global supply chain prior to government intervention or after. If corporate leaders oppose leaving the future direction of their firms to be shaped by government action, then they are more likely to learn how to use sustainability in a way that complements their cost and efficiency strategies (Prokesch, 2010).

#### *International standards and regulations*

Next, we discuss a few international topics, which suggest that international standards and regulations will soon be something that all firms must comply with.

(i) *The United Nations Framework Convention on Climate Change.* The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty produced at the "Earth Summit" held in Rio de Janeiro in June of 1992 and 154 nations signed the treaty. The objective of the treaty was to stabilize GHG concentration in the atmosphere at a level that would prevent dangerous interference with the climate system. The treaty itself set no mandatory limits on GHG emissions for individual countries and contains no enforcement mechanism; however,

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it set the framework for annual meetings between industrialized nations to discuss the issue of GHGs (Kameyama and Kubota, 2010).

(ii) *The Kyoto Protocol*. The Kyoto Protocol is an international agreement linked to the UNFCCC (European Commission, 2010). The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European Union for reducing GHG emissions. The agreement was adopted in Kyoto, Japan on December 11, 1997 and entered into force on February 16, 2005. Under the treaty, countries must meet their targets primarily through national measures. If unable to meet these goals by means of reduction, the treaty also offered countries the ability to meet their targets through emissions trading (also known as cap and trade), clean development mechanism (investment in technologies which reduce carbon emissions), or joint implementation (co-invest with other member countries in technologies which reduce carbon emissions). To comply with the agreement countries' actual emissions have to be monitored and precisely recorded. As of July 2010, 191 states have signed and ratified the protocol (UNFCCC, 2010).

(iii) *The Copenhagen Summit*. The 2009 United Nations Climate Change Conference, also known as the Copenhagen Summit, was held in Copenhagen, Denmark in December of 2009. With representatives from 192 countries attending the "Summit", it signified that a majority of the world's governments believe that climate change poses a threat to human society and to the natural world and hopes was high for a "binding" agreement that would replace the aging Kyoto Protocol. Unfortunately, high jacked by the failing economy, the Copenhagen Summit came up short of a binding agreement. The Copenhagen Accord, the only tangible result of the 12-day event, is a plan drafted by the USA, China, India, Brazil, and South Africa which could be signed in a voluntary way (BBC News, 2009). Though a number of countries submitted their promises for cutting carbon emissions, they also announced that they would only continue to provide their full support if it was promised to never become a binding international treaty (Giddens, 2010).

(iv) *Cap and trade*. Under a cap and trade approach, a central governmental body would set a limit (or cap) on the amount of a pollutant that can be emitted. Firms or other groups are issued emission permits and are required to hold an equivalent number of allowances which represent the right to emit a specific amount. Firms that need to increase their emission allowance must buy (or trade) credits from those who pollute less. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions by more than was needed (Center for American Progress, 2008). If a new cap and trade system is implemented internationally, the US Chamber of Commerce estimates that diesel fuel could increase by as much as 88 cents per gallon. For the freight industry, which the cost of fuel purchased today to make deliveries may not be recouped for 30, 60, or 90 days; such fuel cost increases would potentially have a devastating impact (Patton, 2009). There is no telling how much of these additional costs will be able to be pushed further down the supply chain to the end-user.

### **Implementing sustainability in the logistics function**

There are numerous areas throughout the supply chain where sustainability can be implemented. As mentioned prior, implementing sustainability requires a great deal of creativity, however, the benefits that can result are well worth the effort. Figure 2 shows

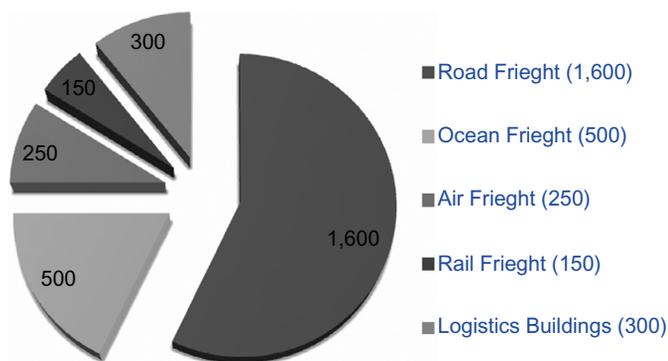


cost of logistics. They include transportation, inventory management, and information flow. Supporting activities are still fundamentally important, but may not be as significant to each firm. These activities include warehousing, materials handling, purchasing, protective packaging design, and information maintenance (Ballou, 2004, p. 10).

(a) *Transportation.* With billions of products in transit every day, transportation requires a large amount of fossil fuels. The burning of these fossil fuels causes GHG emissions, such as carbon dioxide (CO<sub>2</sub>) that can have a major negative impact on our environment and individual health. To ensure that they are not adding to the growing GHG problem, logistics managers must make good decisions about the mode of transportation they use to transport their products. The World Economic Forum (2009) estimated that the logistics and transport sector has a carbon footprint of around 2,800 mega-tonnes CO<sub>2</sub>. In absolute terms, road has the largest share, at around 57 percent of the total, with ocean freight some way behind at 17 percent. Figure 3 shows a look at the amount that each logistics activity and transportation mode contributes to total logistics emissions.

Of course, the above figure does not imply that road freight is the least efficient mode of transportation. Assessed in terms of emissions intensity per tonne-meter, airfreight is more carbon intensive than road, clearly shown in Figure 4. An International Maritime Organization (2006) report showed that amount of fuel consumed, and hence amount of CO<sub>2</sub> emitted, is very sensitive to vehicle load factors. The authors note that trucks consume more than twice as much fuel per ktonne as rail.

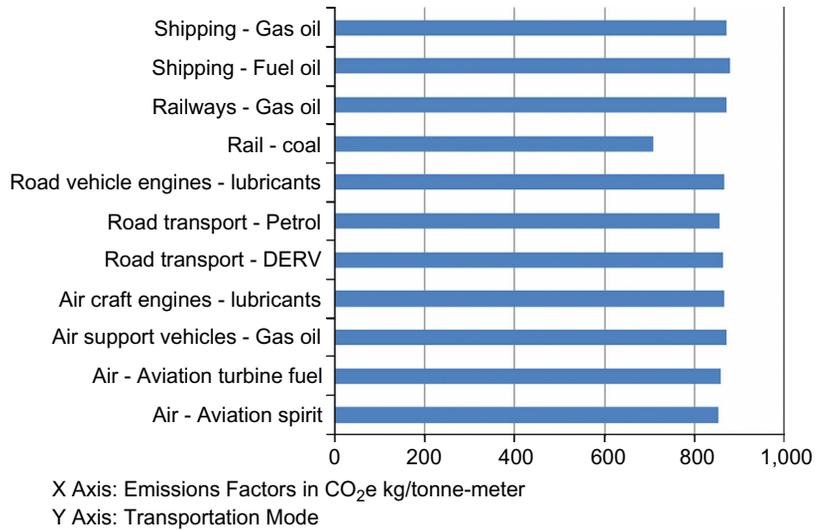
Firms who often promote particular transportation modes as being more “green” often base their calculations on high levels of utilization while only using average-based factor data for competing modes. Overall, when assessing the amount of tonnage each can carry, the most carbon efficient modes of international trade are rail and ocean freight since the carbon concentration for each of these modes is approximately one sixth of that of road freight, or one hundredth of that of airfreight (World Economic Forum, 2009). The amount of carbon emissions produced per transportation mode provides additional support that intermodal transportation is the most efficient way to ship goods (Winebrake *et al.*, 2008). Firms with the ability to ship goods using water freight and rail freight for long distances while reducing the amount of road time, will not only make



Values are in megatonnes of carbon

Source: Adapted From World Economic Forum (2009)

**Figure 3.**  
Emission share per logistics activity  
Adapted from:



**Figure 4.**  
Emission efficiency  
per transportation mode

**Source:** Adapted From Defra Emissions Factors (2009)

an impact financially, but also environmentally (World Economic Forum, 2009). Furthermore, increased attention has been focused on clean vehicle technology through two important methods; improving the efficiency of vehicles in their day-to-day operations and switching to alternative or hybrid fuel technology sources. While adoption rates have been low for both bio-fuelled and battery powered vehicles, these technologies are becoming increasingly viable and adoption rates are expected to rise in the near future (Brooks, 2009; Food Logistics, 2007).

Until such technologies and alternative fuel sources develop, multiple firms have implemented creative solutions using less sophisticated techniques and technologies to reduce their dependency on fossil fuels. These techniques and technologies include cruise control, reductions in left hand turns, GPS units, and automatic engine shut down devices. For example, a recent study revealed that The Kroger Co. with the aid of some eco-friendly fleet management tips (called “preventative fleet management”) has been able to implement and maintain a long-term sustainability strategy and also reduce their carbon footprint (Burnson, 2008).

*(b) Inventory management and warehousing.* Logistics managers certainly play a crucial role in the amount of inventory a company keeps on hand and at warehouse locations. Because of the significance of the carrying costs associated with owning inventory, managers implement a number of techniques to keep inventory levels to a minimum. Some of these techniques managers use include reducing demand variability, improving forecast accuracy, reducing supplier lead times, reducing manufacturing lead times, improving supply reliability, and reducing the number of items (Ballou, 2004). Using these techniques to reduce costs can also have a positive impact on a company’s carbon footprint as well. Keeping reasonable inventory quantities on hand will prompt the need for smaller facilities. This then will translate into less energy expended in heating and cooling the storage area for raw materials, finished goods, and employees

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(Franchetti *et al.*, 2009). Dekker *et al.* (2009) draws on the areas of logistics and inventory management to show that if firms send their shipments to intermodal terminals, storage costs can be lowered and response times shortened. Such advance positioning provides an opportunity for intermodal transport providers to green the supply chain as the environmental impact per ton mile is lower than road transport.

Logistics managers all over the world are finding numerous ways to reduce the energy that their logistics buildings are consuming. One unique way to reduce energy consumption is by harnessing natural light. Natural light not only saves on utility expenses, but employees working during normal business hours appreciate it as well. Many firms are building factories and warehouses with larger windows or skylights (Bellona, 2009). Similarly, the savings from regular maintenance and efficient replacements can add up as well. For instance, by changing incandescent light bulbs to compact fluorescents, a company can save up to 75 percent in lighting costs and the bulbs will last ten times longer. For a warehouse in Cleveland, OH such activities resulted in energy bill savings of \$10,668 per year (Hampshire, 2010).

(c) *Information flow, purchasing, and protective package design.* The flow of information through the supply chain is certainly a key component of efficient inventory management and the movement of goods. Firms can put in place a number of information systems to increase the accuracy of communications between both their suppliers and their distributors. As suggested prior, one of the most important activities that a company can do to reduce their carbon footprint is to maximize the utilization of space in each shipment. With good communications, empty trucks that recently delivered goods can be rerouted to the nearest supplier to re-supply warehouses, reducing the amount of “empty driving time” (Fugate *et al.*, 2009; Esper and Williams, 2003).

Manufacturers have increasingly turned to their suppliers or third-party logistics providers (3PL’s) to implement sustainability through their supply chain (Kilby, 2008). This trend is often referred to as “responsible sourcing”, and requires a great amount of communication between the company and their service providers. Not only is it important to communicate the standards of the corporation, but also to put in place the tools in order to monitor how service providers are performing. An example of a company that failed to monitor the quality of their suppliers’ materials is the toy company Mattel Corp. Mattel recalled approximately 14 million toys over a period of a few years and was forced to pay \$2.3 million in civil penalties and suffered severe damage to its reputation. Without consent of Mattel, Mattel’s Chinese suppliers were using excessive levels of lead in toy surface paints and small detachable magnets in some toys. This example illustrates problems faced by firms in managing their global supply chains and getting blamed for ethical lapses committed by their contractors and subcontractors (Roloff and Abländer, 2010; Enderwick, 2008).

Finally, packaging provides an opportunity for suppliers, manufactures, and 3PL’s to implement sustainable practices (Routroy, 2009). Updating packaging by brand owners to a sustainable eco-friendly manner can build customer loyalty as well as result in higher ratings on retailer’ sustainability scorecards (Boch, 2010). Twede *et al.* (2007) interviewed experts and managers in the warehousing and material handing industry to assess the current and future trends for pallet usage in the grocery distribution industry. The authors found that increasing fuel price and new regulations places the “humble” wooden pallet as a key component for sustainable packaging in modern grocery distribution. The study concludes that the industry should not only look for substitutes

like plastic pallets but also must make a conscious effort to redefine the business as material handling, movement, and flow (Twede *et al.*, 2007).

As mentioned prior, implementing many of these techniques cannot only make the supply chain more sustainable, but efficient as well. For logistics managers, many of these techniques that can make packaging, communication, and inventory more proficient ultimately have a positive effect on the cargo weight-to-bulk ratio (volume). Thus, managers can better utilize the space made available in each transportation mode and facility.

(d) *Reverse logistics.* While traditional logistics seeks to organize forward distribution, that is the transport, warehousing, packaging, and inventory management, environmental considerations have opened up markets for recycling and disposal. Reverse logistics involves “a process whereby firms can become more environmentally efficient through recycling, reusing and reducing the amount of materials used” (Carter and Ellram, 1998). While reverse logistics is widely used, other names have been applied, such as reverse distribution, sustainable end-of-life cycle, and green logistics. Supply chains feel compelled to adopt reverse logistics activities because of competitive, marketing, economic, and environmental reasons (Shankar *et al.*, 2008). Barker and Zabinsky (2010) identify – government legislation, significant economic value of a used product and compliance to customer expectation of “green” company image, as three compelling motivators to incorporate reverse logistics into their operations.

Though there are multiple benefits and drivers for a company to implement reverse logistics (Meade *et al.*, 2007), implementation is extremely difficult and firms often perceive that barriers to be greater than the advantages (Rogers and Tibben-Lembke, 2001). For example, a manufacturer’s distribution system is typically designed for efficient forward flow resulting from multiple years of experience; however, introducing reverse logistics is a new concept and thus can be costly and inefficient. One way to implement reverse logistics is how firms can redesign their forward distribution system to include reverse logistics functions. Functions that the logistics managers need to consider to implement reverse logistics are: collection, sorting and testing, and reprocessing (Barker and Zabinsky, 2010). Table I shows a decision guide for the three reverse logistics functions.

Review of extant literature reveals increased attention in the field of reverse logistics both from a practitioner and research perspective (González-Torre *et al.*, 2010). Initially, reverse logistics was used to refer to the reverse direction (forward direction being that goes from suppliers to final customers). Then the literature on reverse logistics started to include environmental aspects (Chakraborty, 2010; Ciliberti *et al.*, 2008). Studies have focused both on the economic and environmental aspects of sustainability to understand the benefits and impact on supply chain performance as well as to investigate the barriers to implementation of reverse logistics practices in various industries (Dowlatshahi, 2010; Rubio *et al.*, 2008; Skinner *et al.*, 2008; Kumar and Putnam, 2008). In a recent paper, Sarkis *et al.* (2010) note that relationship of social responsibility and reverse logistics practices is not studied in depth. The authors based on practical examples from industry link reverse logistics practices with sustainability indicators to build a theory of reverse logistics for social responsibility.

Next, we discuss how certain firms have set the benchmark for sustainable practices, and provide some short- and long-term recommendations for the successful implementation of sustainability.

Stage	Decisions	Considerations
Collection	Proprietary collection	High degree of producer control; protects proprietary intellectual knowledge; enhances direct customer relationships
	Industry wide collection	Good for commodity-type high-volume product; potential to share costs with other producers; often used for government mandate; does not complicate existing supply chain
Sort-test	Centralized sort-test	Preferable for high-cost testing procedures; good for commodity-type high-volume product; simplifies network
	Distributed sort-test	Preferable for low-cost testing procedures; avoids shipping scrap; transportation costs can be done by third-party providers
Processing	Original facility processing	Preferable for refurbishing, spare parts recovery; high degree of producer control; no need to add separate facility; simplifies network
	Secondary facility processing	Good for commodity type high-volume product; potential to share costs with other producers; can be done by third-party providers; may complicate network

**Table I.**  
Decision guide for reverse logistics

**Source:** Adapted from Barker and Zabinsky (2010)[1]

### Recommendations for implementation

Procter & Gamble (P&G) define sustainability as “ensuring a better quality of life for everyone, now and for generations to come” (P&G Sustainability Report, 2010). P&G managers ensure sustainability is always a focal point throughout their innovation processes “to improve the lives of the consumers with high-quality products that represent good value” (Moss Kanter, 2008, p. 45). P&G developed “Sustainability Reports” to measure and track each of their sustainability initiatives on an annual basis. Finally, P&G executives believe that they have greatly benefited from the return on investments made through the program in terms of improving reputation, employee morale and productivity, recruiting and retention of the best employees, and reduced regulatory costs (P&G Sustainability Report, 2010).

UPS, a key player in the transport and logistics industry, has been focusing its sustainability initiatives on four broad areas – community, marketplace, workplace and environment (UPS Study, 2010). A few of the programs implemented by UPS are – launching new green products (carbon-neutral shipping), using alternative fuel delivery vehicles, leveraging multiple transportation modes to ensure a fuel-efficient delivery network and reducing the noise and carbon emitted by its airline fleet. Through its capabilities and methodologies for transport efficiency, UPS has increased its fuel economy (measured in MPG) for its ground fleet by 10 percent, and achieved 3 percent annual reduction of CO<sub>2</sub> emissions. UPS also improved its on-road fuel economy by 28.9 percent with the inclusion of hybrid diesel electric delivery vehicles in its ground fleet. TNT N.V., a global leader in logistics operations, have also emerged as a leader in sustainability initiatives with activities targeted to make sustainability a part of company culture (TNT Study, 2010). The most significant of TNT’s initiatives, the Planet Me program is designed to reduce emissions and increase efficiency of the firm’s operations globally and across all sectors and has the key objective “to be the world’s first zero-emission transport company” (TNT Planet Me, 2011). A. P. Moller – Maersk, one of the world’s largest shipping firms, have undertaken sustainable programs in areas like ship recycling, waste handling and the use of a voyage efficiency system

(Maersk Study, 2010). Maersk have introduced the Green passport scheme that involves safe dismantling of ships once they are no longer fit for use. FedEx has teamed up with the Environmental Defense Fund on an ambitious project to make the standard delivery truck more environmentally friendly. As a result of that initiative, FedEx currently operates 330 hybrid-electric delivery vehicles, including an all-hybrid station in New York City. The hybrid trucks improved fuel economy by 42 percent, reduced GHG emissions by 25 percent and cut particulate pollution by 96 percent. In addition to the hybrid-electric vehicle initiative, FedEx operates 58 trucks fueled by compressed natural gas, liquefied natural gas and liquefied petroleum gas, in Europe, the Asia Pacific and Latin America. FedEx also has more than 320 LPG and electric-powered ground support equipment in use at its hub in Paris and other operational facilities across Europe, with another 55 on order (FedEx Study, 2011). Many of these firms have won a number of awards for their sustainability measures as well as scored very high on indices such as the Dow Jones Sustainability Index (DJSI) and the Carbon Disclosure Leadership Index (CDLI) (UPS Study, 2010). The DJSI is the first global index tracking the financial performance of the leading sustainability driven companies worldwide, thus providing further solid evidence of a positive relationship between sustainability practices and firm financial performance.

Other examples of best of breed practices include General Electric's ambitious Ecomagination project, Coca-Cola's efforts to protect water quality, Wal-Mart's ability to reduce packaging waste, and Nike's removal of toxic chemicals from its shoes (Fromartz, 2009). However, Unruh (2008) identified Alcan as a worst performing organization where Alcan managers described sustainability as an endless journey. After extensively studying ten sustainable firms, Pagell and Wu (2009) point out two unique common themes for each company:

- (1) financial goals and environmental goals are aligned; and
- (2) supply management has a deep social dimension and is integral to the organizational culture that attracts and retains dedicated employees and suppliers.

On the contrary, van Hoek and Johnson (2010) note that economic performance considerations and not environmental and social performance, still largely drive organizational decision making based on their roundtable discussion with leading academics and case examples of two leading global organizations (Wal-Mart and Cisco Systems).

Throughout this paper we provided examples of why sustainability is important to implement within the global supply chain and how small, medium and large firms are continuing to adopt new, credible approaches to sustainability. Such strategies can unlock a great deal of business potential even if this is not always precisely quantifiable: a lower consumption of natural resources, reduced costs, optimized operating processes, improved business relationships, decreased risks, and higher employee motivation. These benefits result in improved product quality, innovations, and increased competitiveness, all of which will pay off through increased profits and shareholder value. Firms who do not operate under sustainability run huge financial risks. This was illustrated in the case of Nike and Shenzhen Energy Group which both suffered financial consequences.

Below we suggest some short- and long-term recommendations that a company can use to implement sustainability within their global supply chain.

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*Short-term recommendations*

*Start today.* There is no better time to start moving the company towards becoming more sustainable than today. There is a Chinese proverb that states, “The best time to plant a tree is 100 years ago, the second best time is today”. In light of the existing and more upcoming regulations, the need to be sustainable has never been more urgent. Also, a failure to do so could have a negative impact on operating costs – the rise in fuel and energy prices is a case in point. A quest towards sustainability also has other benefits like increased brand value (or least little risk towards a negative impact on brand value) and making the firm’s product and services attractive to a distinctive segment of customers.

*Start simple.* There are a lot of simple things firms can do that do not require a significant investment. For starters, firms can study their facilities and learn where they are most inefficient. For example, within the logistics operations field, looking at asset (transportation and warehouse capacity) utilization, revisiting the issue of packaging, recycling of pallets and crates, etc. are some of the areas that can be immediately tackled within the firm. Many of these small tasks that can be immediately implemented can engage employees and facilitate creativity. Other areas external to the firm, like extending sustainability efforts to suppliers can follow later on and can be part of the firm’s long-term strategy towards sustainability, since such initiatives take greater time and resources to be pursued and implemented. But it should be remembered that a lot of opportunity lies in extending the sustainability effort through the supply chain and this should not be postponed for too long.

*Top management must become committed.* Sustainability begins with top management due to the need for resources and for the fact that sustainability requires a commitment that is firm wide and is not simply restricted to one department or function. In that angle, sustainability initiatives are similar to those of total quality management and lean, i.e. sustainability is everybody’s responsibility with an organization. However, responsibility cannot be delegated without authority and giving employees the freedom to make decisions within reasonable limits will not only reduce bureaucracy but will also motivate employees to come up with creative and simple ideas, which otherwise may have been overlooked (Prokesch, 2010). Top management must provide support in creating detailed standards that are enforceable.

*Create a visual representation of your global supply chain.* Creating a simple visual representation of your global supply chain on paper will allow management to focus on each area, identify opportunities and develop better ideas where sustainability can be implemented. It can also identify risks within the supply chain that can have a negative impact on account of non-sustainable practices – like in the case of Mattel.

*Benchmark each area of the global supply chain against other firms.* Table II shows an example of a balance scorecard that can be used to benchmark your company against other firms. This will help provide a sense of measurability, which can be analyzed. Such a balanced scorecard analyzes the sustainability efforts in each of the areas of supply chain logistics operations referred to in Figure 2 earlier (i.e. the “supply chain”, value adding chain, distribution chain, and the reverse logistics chain). Within each area, different sub-areas are examined with the intent to examine the firm’s sustainability efforts with those of other firms within their industry and the “best-in-class” firm. A series of questions need to be answered in each sub-area with the response to each question recorded on a 1-5 scale with a score of 1 indicating that the firm compares least favorably with other firms in the industry and a score of 5 indicating that the firm

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**Table II.**  
Sustainability balanced  
scorecard

Function/characteristic	Sustainability scorecard				
	Q4	Q3	Q2	Q1	Ave.
<i>Supply chain (total)</i>					
Supplier collaboration					
Product/package ratio					
Cube utilization					
GHG produced by transportation					
<i>Value adding chain (total)</i>					
GHG per ton of production					
Material waste					
Innovations leading to reduced GHG					
<i>Distribution chain (total)</i>					
Distributor collaboration					
Product/package ratio					
Cube utilization					
GHG produced by transportation					
<i>Reverse logistics (total)</i>					
Recycled content					
Recovery value					
Innovation					

**Note:** Each characteristic ranked on a scale of 1-5 (1 – least favorable; 5 – most favorable)

compares most favorably. Use of such a balanced scorecard can and also help the firm keep abreast of initiatives taken by their potential competitors towards sustainability and create an opportunity to learn from them.

#### *Long-term recommendations*

*Stay ahead of government regulations.* Firms are far better off creating their own future as opposed to reacting to government regulations. Management should anticipate where governments would enforce new measures that might become detrimental to operations. As mentioned before, carbon emission and other logistics regulations is not a matter of “if”, but a matter of “when”. The meeting of world leaders specifically devoted to “climate” talks is also another indication of how serious and important sustainability has become on the world agenda. Top management must be proactive in implementing sustainability throughout their global supply chain prior to government intervention as such a move will provide them with competitive advantage in terms of the time, resources and costs required to comply with the regulations.

*Set measurable carbon goals.* Measure the amount of carbon emissions that the company emits and create goals to encourage reductions. In line with being proactive with respect to governmental regulations, firms need to also get on the “cap and trade” (emission trading) bandwagon and learn the rules of the game as it is being practiced in certain parts of the world – especially Europe. Although recent political developments makes such an emission trading system unlikely in the US in the very near future, such a system or one similar to it could see the light of the day few years later. Another step in this direction that firms need to take is in measuring the carbon footprint for the products and services being provided by the firm and developing a visual representation of the firm’s supply chain can help towards such an effort.

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## Conclusion

Growing concerns over issues such as the limitation of resources, global warming, GHGs, and consumer health have increased the urgency for firms to incorporate sustainability into their strategies. With the rise of today's "conscious consumer", adding sustainability into the corporate strategy has become about meeting the expectations of investors while taking into account the long-term impact that operations have on the community and environment. A focus on supply chains is a step towards the broader adoption and development of sustainability, since the supply chain considers the product from initial processing of raw materials to delivery to the customer. A logistics operation represents the integrated management of all the activities required to move products through the supply chain and holds tremendous potential for a firm's quest towards sustainability. However, there is very little work done to understand the role and importance of supply chain logistics operations towards this end. The combination of monetary cost and environmental impact that logistics contributes to operations makes it a key area and there exists a need to explore opportunities to strengthen logistics and make it more efficient. We discussed areas throughout the firm's logistics operations where sustainability can be implemented such as the "supply chain", value adding chain, distribution chain and the reverse logistics chain. We have identified and discussed opportunities for introducing and continuing sustainable operations in each of these logistic functions. We also make the case for why all firms must begin implementing sustainability practices immediately including because of the benefit to a firm's brand value, the ethical and economical need to reduce the misuse of (especially non-renewable) resources and the inevitable governmental regulation and intervention.

We recommend that firms start their quest towards sustainability as early as possible (today) in a simple manner by implementing internal practices which are easier to roll out in the short run and extend such initiatives externally through the firm's entire supply chain in the long run. Towards this long run goal, the first step would be to develop a visual representation of the firm's supply chain that will aid in identifying opportunities and develop better ideas where sustainability can be implemented and also help the firm measure the carbon footprint of its products and services, which will be a necessary pre-requisite to participate in a "cap and trade" system. Another important recommendation we provide is to make use of a balanced sustainability scorecard that can be used to benchmark a firm's sustainability efforts against other firms in the same industry. The bottom line is that sustainability initiatives can be used by firms to differentiate themselves from their competitors, reduce costs, and improve services to their customers.

## Note

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