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## Conference Paper

# Is Money Really Green? - An Investigation Into Environmental Supply Chain Practices, with a Cost Focus

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# Is Money Really Green? - An Investigation Into Environmental Supply Chain Practices, with a Cost Focus

John Bancroft

## **Abstract**

In the setting of the supply chain and the environment, logistical operations are the most visible and contribute significantly to CO<sub>2</sub> emissions (Dekker et al., 2011); Tol (2006) suggests that transportation accounts for 14% these emissions. As most products consumed have a global footprint it is important that logistics is managed with a green and cost effective approach.

For third party logistics providers and in-house logistics operations to reduce CO<sub>2</sub> emissions and "green up" their operations, it must be possible to do this whilst remaining competitive in areas such as cost, reliability and performance. Without this, it is unlikely that logistics providers will voluntarily make changes to their operations. This research paper will investigate current green initiatives as well as future approaches and evaluate them, focusing on those which can maintain or reduce costs whilst sustaining performance and reliability.

Investment in environmentally friendly distribution practices has become a must for organisations; the degree to which this is practiced and invested in varies significantly. The motivation for this investment could be for numerous reasons; a genuine care for the environment, legislation, pressure from environmentalists or due to an increase in the cost of fossil fuels. For investment to be facilitated it must be sustainable fiscally, or these practices cannot be continued. Helper et al. (1997) and Conrad and Morrison (1989) suggest that previous attempts to reduce the impact of supply chain practices

have frequently increased costs, thus discouraging investment in such practices.

**Keywords:** green, cost focus, reliability, performance

## 1. Introduction

In the later part of the 1900's to the present, there has been a growing focus on the damage that individuals and corporations are causing to the environment. This will undoubtedly continue as long as it is evident that the environment around us is deteriorating; natural resources are depleted, Carbon Dioxide (CO<sub>2</sub>) emissions continue to rise and landfill sites become overfilled. Enter green logistics, often facilitated by corporate social responsibility (CSR) and regulative/legislative pressure.

Managers are recognising the importance of appearing green to an organisation's reputation and how that can currently be an order winner, and as regulations become stricter, this will one day act as an order qualifier (Murphy et al., 1995). Some customers are willing to pay extra for green services and products; a survey from Reuters further enforces this idea. "Some 48 percent of the people surveyed also said they were prepared to pay a little bit more for sustainable goods." Similarly the same survey consisting of 20, 000 people from 10 countries also shows that "80 percent would reward brands that adopted sustainable practices" and that "72 percent would punish those that did not." (Reuters, 2009).

Additionally, whilst there is some debate as to when fossil fuels will be depleted, there is a consensus that it will happen. Shafiee and Topal (2009) hypothesise that "fossil fuel reserve depletion times for oil, coal and gas of approximately 35, 107 and 37 years, respectively." As a result of this factor it is necessary to find suitable green alternatives to these fuels.

Whether or not logistics can be made environmentally friendly or green, fiscally and economically effective, and maintain reliability and performance will be the focus of this paper.

This paper will follow an inductive approach, exclusively using secondary data, qualitative and quantitative; from case studies, peer reviewed journals, other academic and industry sources. Exploration of current logistical practices, as well practices considered to be green shall be investigated. Quantitative data will primary consist of CO<sub>2</sub> emission figures, which is considered to be a key performance indicator that can be used to gauge logistical practices and their impact on the environment.

## **2. Green Logistics/SCM**

CSCMP (2011) describes logistics management as “that part of the supply chain that; plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers’ requirements”. Rodrigue et al. (2009) goes on to explain green logistics is “supply chain management practices and strategies that reduce the environmental and energy footprint of freight distribution. The focus is often on material handling, waste management, packaging and transport.” Pazirandeh and Jafari (2013) combine the two explanations and describe green logistics as a form of logistics that is both economically functional and environmentally friendly. Green logistics is all about “the harmonization of efficiency, environmental friendliness and energy conservation” and its goal is to ensure “sustainable development of freight transport...” (Geroliminis and Daganzo, 2005).

The increasing emphasis towards green supply chain management (GrSCM) is predominately motivated by the further decline in the environment, such as lessening availability of raw materials, increasing levels of pollution, carbon dioxide (CO<sub>2</sub>) emissions being a common problem and overfilled waste sites

(Srivastava, 2007). “Over the past 10-15 years, against a background of increasing public and government concern for the environment, companies have come under mounting pressure to reduce the environmental impact of their logistics operations” (McKinnon et al., 2010).

Zhu et al. (2007), has suggested that green supply chain and logistics practices, can have three impacts on an organizations performance:

Environmental performance, such as the reduction of CO<sub>2</sub> emissions, waste reduction and a decreasing use of materials and therefore generally less waste.

Economical performance, which can lead to increases in some costs and decreases in others. Such as decrease of material and energy cost and increases in the cost of training employees.

Operational performance, such as improved capacity utilization and decreased inventory levels.

A fourth impact can be included; this is the increase in one-off investments, which is quite often typical of green logistics, as new technology/upgrades are required such as vehicles. Green vehicles typically cost more than their traditional counterparts (Dizikes, 2012). For example an electric delivery vehicle can cost up to \$150,000, whereas a traditional delivery vehicle is likely to only cost approximately \$50,000. UPS (2013) have found by introducing 100 electric delivery vehicles into their fleet, there can be a saving of 126,000 gallons of fuel per year. With the average price of gas per gallon at \$4.11 (California Energy Commission, 2014), this would amount to fuel savings of approximately \$500,000, not to mention the significant reduction in CO<sub>2</sub> emissions and noise. However these vehicles still need a charging source and where that energy comes from, will dictate the actual net savings in both costs and CO<sub>2</sub> emissions. The current issue is that many charging sources for electric vehicles (EV) currently derive their energy from un-green sources, usually fossil fuels (Thomas, 2012). Consequently, whilst a vehicle may not have any tailpipe emissions, there is still a carbon footprint associated with the energy used to run that vehicle. Thomas (2012) goes on to argue that even if all US light duty vehicles (LDVs) were replaced by a combination of battery EVs and plug-in

hybrids, green house gasses (GHGs) would be at most reduced by 25% and oil consumption could be reduced by less than 67%. However if all these vehicles were replaced by fuel cell electric vehicles powered by hydrogen made from natural gas, GHGs would be reduced by 44% and oil consumption by almost 100%.

However if like Tesla, these sources can be derived from clean, renewable and non-polluting energy sources, such as solar, the CO<sub>2</sub> are virtually zero. Tesla are currently making radical improvements to the U.S electric vehicle charging infrastructure, of which, all of this energy is from clean solar energy and their aim is that by the end of 2015 98% of the U.S population will have access to these charging stations (Tesla, 2014). Equally by the end of 2015, the majority of Western Europe will also be covered with these Supercharger stations. While Tesla is radically developing the infrastructure for EVs, the issue currently is that this is specifically for Tesla owners and it is currently incompatible with other EVs; there are talks of this changing and accessibility being made for any EV, where the manufacturer is willing to work to Tesla's cost structure as well as the vehicular being designed so it is capable of accepting the power that the Supercharger provides (Hruska, 2014).

### **3. Conflicts and Matches**

There are a variety of approaches available for adoption by organizations that will green up logistics and throughout the supply chain, however not all of these are a viable option.

Frequency and size of deliveries can be an issue when it comes to green logistics. Rodrigue et al. (2001) state that with green logistics "the idea is not for smaller and more frequent shipments which would result in more trips by smaller vehicles." Rodrigue et al. (2001) continues to state that green logistics aims to minimize the number of deliveries (trips) made, therefore implying the use of larger vehicles, filled to capacity and therefore moving more materials or products with less frequent deliveries. This would immediately conflict with any

organization following a lean approach, whereby smaller more frequent deliveries are encouraged and therefore a buildup of inventory would occur throughout the supply chain.

A build up of inventory generally equates to higher labour costs as well as handling equipment being required. In addition to this more materials usually leads to problems being hidden, such as quality defects. (Jacobs and Chase, 2008). What initially would appear to be simply extra storage space required soon leads to additional costs which spiral into unimagined costs, in the forms of transport, storage and general waste.

Continuing with the focus of road transportation and the size of vehicle, perhaps the most common green KPI is CO<sub>2</sub> emissions, usually measured in grams per kilometer, CO<sub>2</sub> (g/km). The assumption previously discussed is that more frequent deliveries, in smaller vehicles, will lead to more CO<sub>2</sub> (g/km), however if larger vehicles are used to make less frequent deliveries, these emissions should be lower. Pirog et al (2001) measured the average emissions from three categories of road transport these were; heavy-duty trucks, midsize trucks and light trucks (below).

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Transport Mode	Maximum Load (kg)	Fuel Type	Specific total CO <sub>2</sub> emissions (g/ton-km)
Heavy-duty truck	17,300	Diesel	62
Midsize truck	6,000	Diesel	122
Light truck	700	Gasoline (Petrol)	459

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Tab. 1: Road Transport CO<sub>2</sub> Emissions (Venkat and Wakeland, 2006)

The three truck sizes and their CO<sub>2</sub> emissions are measured in grams of CO<sub>2</sub> per metric ton per kilometre. The above table shows that the larger the vehicle load size (kg), the less the CO<sub>2</sub> emissions (grams) per ton per kilometre. Jones and Womack (2002) and Venkat and Wakeland (2006) examined a windshield

wiper supply chain and use the above figures to create calculate its CO<sub>2</sub> emissions from the logistical activities within this supply chain from three perspectives; an agnostic approach, a lean approach, translating to frequent smaller batches and a green approach, large infrequent deliveries. All deliveries use full-truck and direct deliveries and the return trips are assumed to be efficiently used for other purposes.

Strategy	Vehicle size(s)	Delivery frequency *	Specific total CO <sub>2</sub> emissions (g/ton-km)
Agnostic/Traditional	Heavy-duty and Midsize trucks	Twice a week/Daily	27,292
Lean	Midsize trucks	Daily	27,816
Green	Heavy-duty trucks	Once or twice a week	12,912

Tab. 2: CO<sub>2</sub> Comparison by Delivery Vehicle Size/Frequency in a Windshield Wiper Business (Venkat and Wakeland, 2006)

\*Delivery frequency is dependent on the stage in the supply chain and the intermediaries involved.

While the message communicated from the above two tables, begins to at least suggest that lean and green logistics will have some fundamental conflicts, it also supports the notion that green logistics can reduce costs in some areas. There is a clear link between CO<sub>2</sub> emissions and fuel efficiency, in other words, the fewer emissions produced the more economical or efficient a journey is with regards to fuel consumption.

Another conflict between green and the very nature of logistics is the time and speed involved. "By reducing the time of flows, the speed of the distribution system is increased, and consequently, its efficiency" (Rodrigue et al., 2001).



When organizations achieve this it is often by the most polluting logistics providers and involves using the least energy efficient modes of transportation. There is an emphasis now on quick logistics, both from an organizational standpoint to reduce lead times so organizations further down the supply chain can in turn do the same. Similarly from a consumer perspective, when something is ordered online, the general consensus is that customers want it delivered for as little as possible, but also as quick as possible. With lean logistics this becomes a greater reality, as not only are costs reduced, but with frequent, smaller deliveries it is more likely that what is being shipped will get there faster. Whereas with green, it could be that there are only one or two deliveries made a day, in large heavy goods vehicles, which are loaded to full capacity, to minimize emissions.

As previously mentioned green's speed and flexibility is also lessened by the modes of transport available which are considered green, and with a demand for almost instant gratification with some buyers, it is necessary to use what is considered a high polluting form of logistics in some cases, such as air transport. It is essential to offer reliable logistics, the key performance indicators (KPIs) for reliability are widely agreed upon as being on time deliveries, with the least possible threat of breakage or damage of goods. Rodrigue et al (2001) state that "the least polluting modes are generally regarded as being the least reliable in terms of on-time delivery, lack of breakage and safety."

"Ships and railways have inherited a reputation for poor customer satisfaction, and the logistics industry is built around air and truck shipments ... the two least environmentally-friendly modes" (Rodrigue et al., 2001). Sea freight gives emissions of only 10 to 40 grams of CO<sub>2</sub> per ton per kilometer, seemingly the most environmentally friendly method of logistics, while railway transport has emissions of around 30 to 100 grams of CO<sub>2</sub> per ton per kilometer. Both are considered incredibly environmentally friendly with regards to emissions, however when the drawbacks are considered of both sea freight and railway, it is highly discouraging. Not only is shipping an incredibly slow method of transport, but there are a number of other factors which compound this.

It is important to note the CO<sub>2</sub> emissions emitted by any of the transport modes in figure 1, do not show a complete picture, it merely considers the 'tail-pipe' emissions. Emissions are also produced through the production, refinery, storage and transportation of the fuels used to run these modes (Colville et al., 2000).

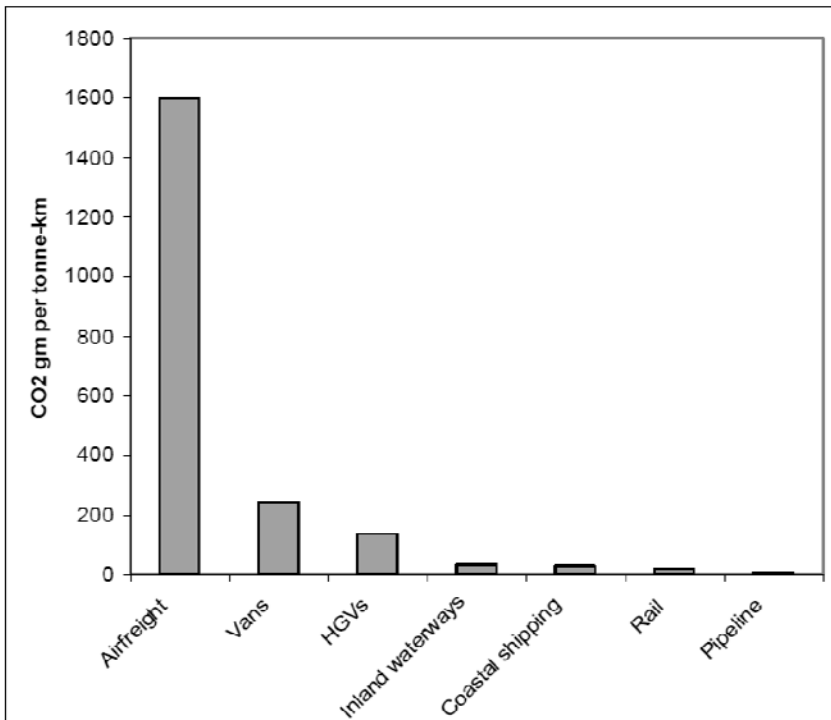


Fig. 1: CO<sub>2</sub> Emissions by Transport Mode (McKinnon. 2008)

#### 4. Conclusions

This paper discusses the approaches available to logistics operations to green up their operations and supply chain management, thusly limiting their impact on the environment. However, it is differentiated from current research by

focusing on the impact of the change to environmentally friendly focus versus the traditional approach; the impact on reliability and economically; two factors which need serious focus for an organization.

## **5. Further Research**

I wish to carry out semi-structured interviews for primary data collection. Participants will include logistics practitioners from third party logistics providers in the UK and logistics professionals/consultants. A focus will be on the implementation and post-implementation phases; looking at upfront costs, the time it takes to recoup or offset any additional costs and effects on reliability and performance.

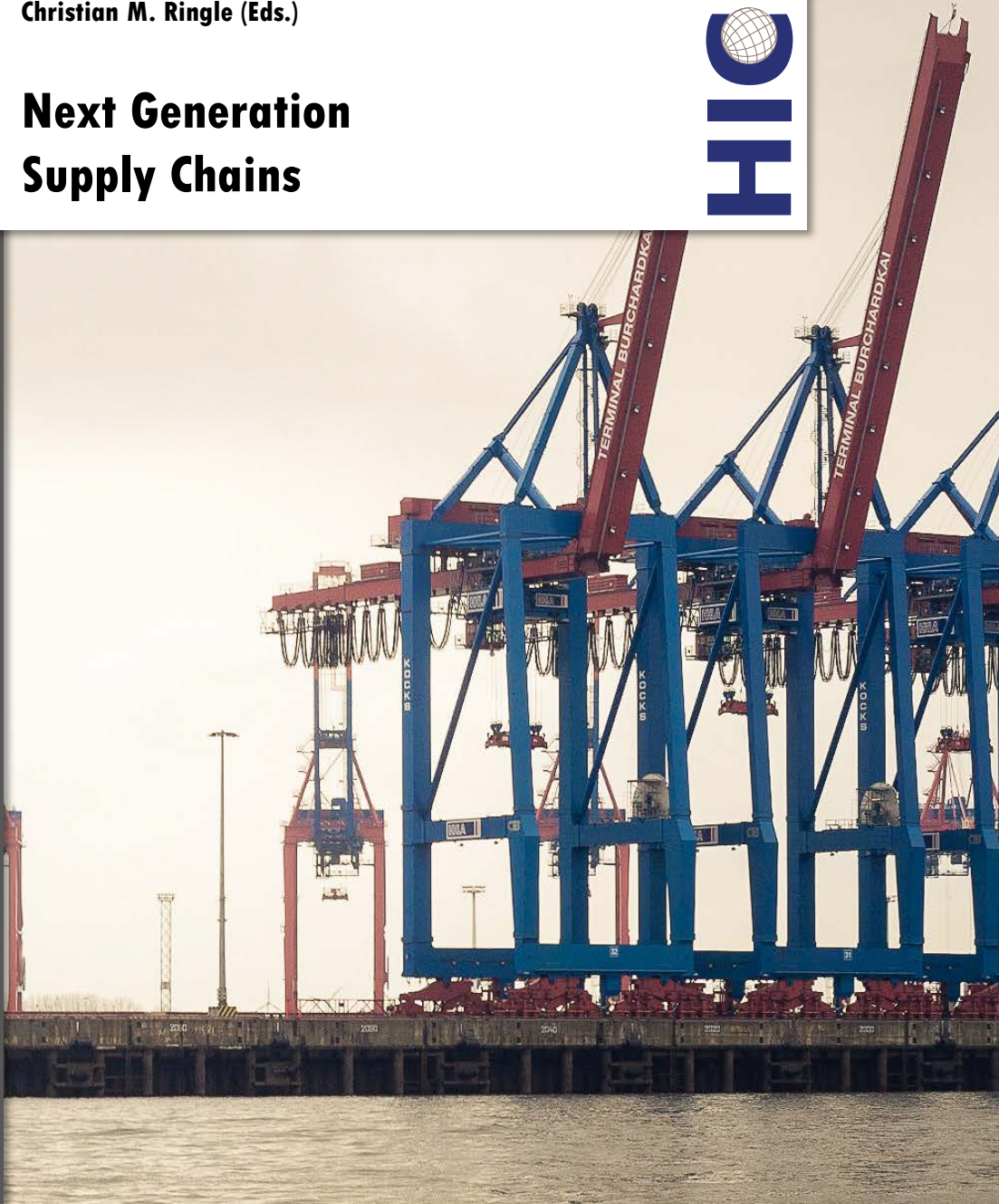
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**Wolfgang Kersten, Thorsten Blecker and  
Christian M. Ringle (Eds.)**

# **Next Generation Supply Chains**



Prof. Dr. Dr. h. c. Wolfgang Kersten  
Prof. Dr. Thorsten Blecker  
Prof. Dr. Christian M. Ringle  
*(Editors)*

# **Next Generation Supply Chains**

Trends and Opportunities

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## Preface

Today's business environment is undergoing significant changes. Demand patterns constantly claim for greener products from more sustainable supply chains. Handling these customer needs, embedded in a sophisticated and complex supply chain environment, are putting the players under a constant pressure: Ecological and social issues arise additionally to challenges like technology management and efficiency enhancement. Concurrently each of these holds incredible opportunities to separate from competitors, yet also increases chain complexity and risks.

This book addresses the hot spots of discussion for future supply chain solutions. It contains manuscripts by international authors providing comprehensive insights into topics like sustainability, supply chain risk management and provides future outlooks to the field of supply chain management. All manuscripts contribute to theory development and verification in their respective area of research.

We would like to thank the authors for their excellent contributions, which advance the logistics research progress. Without their support and hard work, the creation of this volume would not have been possible. We would also like to thank Sara Kheiravar, Tabea Tressin, Matthias Ehni and Niels Hackius for their efforts to prepare, structure and finalize this book.

Hamburg, August 2014

Prof. Dr. Dr. h. c. Wolfgang Kersten  
Prof. Dr. Thorsten Blecker  
Prof. Dr. Christian Ringle

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## **About HICL**

Since 2006 the annual conference Hamburg International Conference of Logistics (HICL) at Hamburg University of Technology (TUHH) is dedicated to facilitate the exchange of ideas and contribute to the improved understanding and practice of Logistics and SCM. HICL creates a creative environment which attracts researchers, practitioners, and industry thinkers from all around the world.



Innovation is increasingly considered as an enabler of business competitive advantage. More and more organizations focus on satisfying their consumer's demand of innovative and qualitative products and services by applying both technology-supported and non technology-supported innovative methods in their supply chain practices. Due to its very characteristic i.e. novelty, innovation is double-edged sword; capturing value from innovative methods in supply chain practices has been one of the important topics among practitioners as well as researchers of the field.

This volume, edited by Thorsten Blecker, Wolfgang Kersten and Christian Ringle, provides valuable insights into:

- Innovative and technology-based solutions
- Supply chain security management
- Cooperation and performance practices in supply chain management

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