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# Green supply chain decisions – Case-based performance analysis from the food industry

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ABSTRACT

Environmental impacts, such as GHC emissions, have been introduced to supply chain management as an additional parameter to traditional cost, lead-time and on-time delivery. Supply chain management represents a significant source of decisions affecting the eco-efficiency of many products. This paper analyses cases from the food industry, mainly order-picking, transportation, warehousing, and distribution aspects from the greening point of view. Three case examples of decisions in supply chain design in the food industry are considered. The results show dependencies between performance measures. Finally, a framework of decisions and their impact on performance is presented.



## 1. Introduction

Environmental sustainability related to supply chains is generally known as green logistics. There seems to be a general consensus about the benefits of green logistics (Meixell and Gargeya, 2005). Environmental advantages for companies include energy saving and cost reduction; economic reasons are fuel efficiency and resource savings.

However, there is a lack of empirical studies and management tools and models which connect environmental performance to general supply chain performance. Some attempts to understand this linkage have been presented by Azevedo et al. (2011), who studied the influence of green practices on supply chain performance by using a case study approach. Yang et al. (2013) studied Taiwanese container shipping companies and their policies. Making a profit requires supply chain management and an essential part of management systems is measuring.

There are a limited number of studies showing how logistics decisions affect not only the economic but also the environmental performance of company and supply chain performance. Some studies support this. For example, Srivastava (2007) claims that there is a growing need for integrating environmentally sound choices into supply chain management research and practice. Also McIntyre et al. (1998) have reported in Saadany et al. (2011) that "*environmental concerns have been examined and treated separately in supply chain functions and there is as yet no integrative approach or mechanism that measures, controls, and improves the environmental aspects of an entire supply chain; a limitation that does not facilitate optimizing the green performance of a supply chain*".

Food supply chains present an important part of the global economy (Baldwin, 2012; Ghosh, 2010). The products are produced and consumed in every part of the world and the processes are related to the use of natural resources, employment, and emissions. Food supply chains present high volume, fast moving products which are accessible to consumers. Food products have certain specific features in terms of supply chain management (Bourlakis and Weightman, 2004) – food has a

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typically short shelf-life, and there are high requirements for traceability and cost pressure (Opara, 2003). According to Cohen and Garrett (2010), fragility and food security are a global phenomenon. Because of these reasons, food supply chains present an interesting research topic on the implementation of green logistics.

The purpose of this paper is to analyse green logistics decisions within the food industry by using a performance measurement framework and to compare alternative scenarios by using financial and environmental metrics. The research problem of the paper is to compare supply chain decisions and analyse where environmental effects are improving, together with cost efficiency and on-time delivery parameters, and when the impacts point to different directions. The remainder of the paper is as follows. Firstly, relevant literature on green supply chains and food supply chains is reviewed. Then three case studies are presented and analysed from the performance measuring point of view. Finally, a framework is presented in the conclusion section.

## 2. Literature

The literature review focuses on papers in the green supply chain management side and on performance measurement aspects which combine economic and green aspects.

### 2.1. Green supply chain management

Rodrigue et al. (2001a,b) define green logistics as "supply chain management practices and strategies that reduce the environmental and energy footprint of freight distribution. It focuses on material handling, waste management, packaging and transport". Byrne and Deeb (1993) differentiate traditional logistics from green logistics in the way that traditional logistics seeks to organize transportation, warehousing, packaging and inventory management from the producer to the consumer. Green logistics includes recycling and disposal logistics, reverse logistics, and other names for it are 'reverse distribution', 'reverse-flow logistics', and 'green logistics'. Saadany et al. (2011) define reverse logistics as collecting used items from the market to recapture value, and greening as a function which "*refers to the forward supply chain functions such as production, purchasing, materials management, warehousing and inventory control, distribution, shipping, and transport logistics*". Srivastava (2007) formulated green supply chain management in that adding green means involving the influence and relationships between supply-chain management and the natural environment.

According to van Hoek (1999), green logistics is not enough and a supply chain perspective is needed. The approach change is from reactive to proactive and value-seeking and from product sales to product life scope, while company scope is replaced by supply chain scope. Green activities include material selection and re-use of materials upstream, (design for) dis-assembly, scrapping, shredding and transportation in mid-stream, and packaging and returns handling and returns shipment downstream. Srivastava (2007) classified green supply chain management into green design, the importance of green supply chain management and green operations, which cover green manufacturing, reverse logistics, network design and waste management.

Supply chains can be greened by reducing energy and first time raw material usage and waste generation, and increasing product recovery options (Saadany et al., 2011). McKinnon (ref) suggests that to reduce carbon emission, freight transport intensity, modal split, vehicle utilization, energy efficiency and the carbon intensity of the energy used in logistics are important.

### 2.2. Food products and supply chains

From the cost point of view, the logistical costs of food production are within the range of 10–15% of the product sales price, which presents an important factor and a common discussion item between producers, wholesalers and retailers. Managing the sustainability of food supply chains from the corporate perspective has become an important priority (Hamprecht et al., 2005).

A great share of the environmental effect occurs in the production stage of food. There is a large variability of overall emission levels between product categories (Katajajuuri, 2007). As an example, Wanhalinna (2010) estimated the $CO_2$ footprint of bread as ranging between 1.4 and 1.7 $CO_2$ equivalent per kg of bread, which is caused by agriculture (45%), baking process (40%) and the consumer side (13%). In order to measure and visualize the effects, eco-labeling is becoming increasingly common in food products. Consumers are requesting this type of information, which can encourage companies to develop also supply chain related sustainability performance (Adams and Larrinaga-González, 2007; Nissinen et al., 2007).

When considering the logistics system, the WRI (2011) report estimates that 13.5% of global greenhouse gases are produced by transportation. From the logistics point of view, the type of vehicle, loading and distance all impact on environmental performance. The food mile (Pretty et al., 2005) is a concept related to the total distance of all supply chain elements, i.e. how long each element has traveled before actual consumption. This type of analysis shows the global dependence of food producers and typically correlates with the environmental effects.

The structures of food logistics are evolving towards integrated systems (Gimenez, 2006). The hub and spoke structure is widely used in food supply chains and describes the distribution network well. High volume and utilization is achieved in transportation between central nodes, also known as hubs or distribution centers. Local smaller nodes (retailers) are then