

Short Communication

An approach to assess logistics and ecological supply chain performance using postponement strategies



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ABSTRACT

This paper presents a methodology that helps managers evaluate how to assess the impact of postponement on supply chain performance considering logistics and ecological criteria. We consider a green supply chain design that considers CO₂ transport emissions under different postponement strategy scenarios using a simulation tool. The paper focuses on a relevant extension of postponement theory by including green considerations into the evaluation of postponement strategies in green supply chain design. Moreover, it provides some insight on how to measure and evaluate the impact of postponement regarding supply chain transport performance, considering different transport mode (container ocean ship and truck) using the European Platform on Life-Cycle Assessment (EPLCA) of ELCD – European Life-Cycle Database. The study has demonstrated that logistics and packing postponement strategies can improve the performance of logistics (total inventory and order lead-time) and, at the same time contribute to reducing the environmental impact of CO₂ emissions from transportation process.

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1. Introduction

The world faces many problems: it is overheating and becoming crowded. In other words, global warming, the rapid ascension of the middle class, and the world's growing population are contributing to make our planet become dangerously unstable (Friedman, 2008). The forecast for the next 20 years is that the global middle class will grow by 1.8 billion and reach almost 5 billion people (Kharas, 2010). This expansion will result in an increased demand for supply chain activities and resources such as energy, food, materials, and water. These changes will have significant impacts on resource demand and environmental issues regarding supply chains. To counteract this trend, according to the McKinsey report (Dobbs et al., 2012), companies have big, profitable opportunities to improve the resource use efficiency throughout the supply chain. However, the implementation of many of these opportunities will require a much more solid cooperation among the participants of the supply chain (Mollenkopf et al., 2010).

Accordingly, supply chain partners have the duty and opportunity to improve their resource use efficiency in the supply chain. In this new context, companies and their supply chains need to improve the productivity – create more with less and deliver

greater value with less input – using resources in a sustainable and efficient way, in order to minimize their impacts on the environment. In order to adapt to this reality and improve the use of scarce resources such as energy, raw materials, and water, a new approach is required to minimize the impact on the environment, such as carbon dioxide emissions and the waste generation. One way to respond to these new challenges is to use postponement strategies (Van Hoek, 2001), which can improve the performance of supply chains through its reconfiguration and efficient management of material flow, achieved by the effective integration of logistics and production processes along the supply chain.

A review of the literature of the area indicates that no previous study has ever systematically investigated how to measure and evaluate the impact of postponement strategies on green supply chain performance. Thus, the objective of this work is to investigate the impact of postponement strategies on supply chains in relation to the logistics performance, especially in relation to the total lead-time and inventory, and the impact on environmental performance in regards to CO₂ emissions in the shipping process.

2. Literature review

2.1. Resource use and environmental impact of supply chain

Hawken et al. (1999) predicted a new industrial revolution based on the efficient use of resources. Today, this has come to mean taking resource efficiency into account for new approaches in

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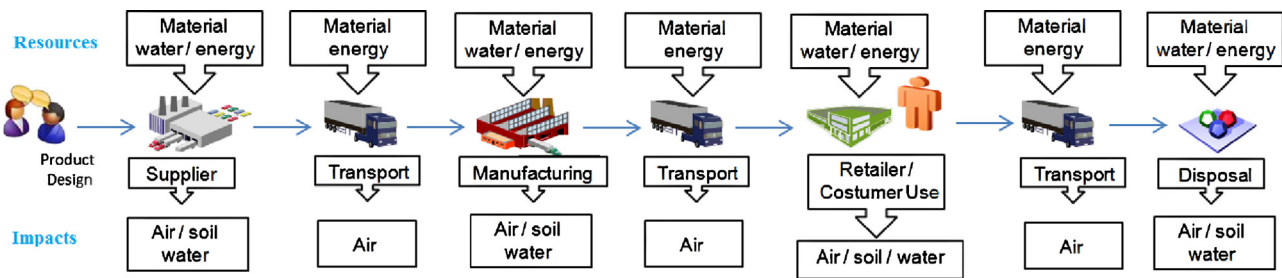


Fig. 1. Supply Chain resource use and environmental impact.

supply chain management research. In doing this, efficient resource use is promoted and environmental impacts are reduced, all while considering the profitability and productivity of all stages of the supply chain. Postponement strategies in the context of supply chains can improve the environmental performance of the supply chain as it slows down the production process and logistics in supply chain projects and improves the efficient management of material flow. This creates a new paradigm for supply chain management: to reach maximum profitability with minimal use of resources and minimal impact to the environment (European Commission, 2011).

Supply chains have great potential regarding their use of materials and resources like water and energy. Their environmental impacts on air, water, and soil can be considerably reduced by decreasing energy consumption, generation of toxic waste, and gas emissions. Fig. 1 illustrates the resource use and the environmental impact of a supply chain.

A supply chain is a system in which significant savings can occur in energy consumption, water use, and waste and gas generation. The answer to this challenge is in the use of postponement strategies to improve logistics and environmental performance, through the reconfiguration of the supply chain and the efficient management of material flow, achieved by an effective integration of logistics with the production process throughout the supply chain. This new supply chain approach is known as the green supply chain management.

2.2. Green supply chain management and postponement strategies

Growing environmental concerns, public pressure and environmental legislation have prompted a move toward sustainability, by means of the green supply chain (Beamon, 1999). The growing importance of green supply chain management is guided mainly by the escalating deterioration of the environment (Sarkis, 2001), and adding the “green” component to supply chain management involves addressing the influence of and relationships between supply chain management and the natural environment (Hervani et al., 2005). Green supply chain management can be defined as “an integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life and this approach can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy use.” (Srivastava, 2007). Several literature contributions exist regarding various aspects and issues of green supply chain management, such as product design, process design, manufacturing practices and product recovery, production planning and control, logistics and network design purchasing, repairable inventory, and reverse logistics.

Independent of various aspects and issues, focusing on green supply chain management requires working with suppliers and

customers, analyzing internal operations and processes, considering the environment of the product development process, and extending stewardship across product life cycles (Mollenkopf et al., 2010). All these green supply chain management characteristics can be related to postponement strategy concepts.

McKinnon (2010) stated that most of the research on postponement has focused on its effects at inventory levels. The most famous postponement strategy is production postponement (form). This strategy can lead to lower inventories and improved customer service levels (Lee and Tang, 1997; Van Hoek, 2001; Yang and Burns, 2003). The direct effect of production postponement in inventories is that it increases semi-finished and work-in-process inventories, because with postponement a product is processed to the point where it remains generic, and finished goods inventories are reduced. The final process to customize the product is delayed until an order is received. A compelling reason to consider production postponement strategy as a way to reduce transport costs is that it delays an increase in volume and weight (Yang et al., 2005).

Logistics postponement is the delay of the forward movement of goods for as long as possible in the chain of operations (time postponement), and keeping goods in storage at central locations in the distribution chain (place postponement) (Van Hoek, 2001). Logistics postponement allows a lower aggregate inventory level and affects the volume and transport flows within the supply chain. According to Van Hoek (2001), shipping products directly to the customer rather than keeping them in stock, even though it should be noted that this might lead to smaller-sized shipments over longer distances, can avoid transportation between warehouses and factories. Thus, it can have positive effects on the carbon dioxide (CO₂) emissions generated by transportation processes. Nevertheless, logistics postponement is often more relevant when products are more sensitive to inventory than transport costs (e.g. higher value added products with large product variety) (Van Hoek, 2001).

Towill et al. (2002) indicates that assembly postponement reduces lead times and results in the most reliable delivery process, which significantly improves the levels of supply chain services (Lee and Tang, 1997; Van Hoek, 2001; Yang and Burns, 2003). However, the reduction in delivery times and the highly reliable delivery process will require a fast, responsive transport system, and the increase in transport speed may have an adverse effect on carbon dioxide (CO₂) emissions. Furthermore, the assembly postponement may potentially help to reduce the dimensions of the product (Van Hoek et al., 1998) and this may reduce the space required for the transport of products. Consequently it also reduces the distribution of transport streams, and the environmental impact of transport can be mitigated.

There is evidence that packaging postponement practices can also have a positive effect on the performance of the supply chain, as this strategy can reduce inventory and transportation costs. The Swedish retailer IKEA sells furniture products in its smallest possible form, which are “flat packs,” later assembled by the customer. In the packaging postponement strategy, distribution costs are low, because they are shipped in bulk to the regional packing center or

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