Green Supply Chain: challenges and opportunities

Green Supply Chain is an interdisciplinary concept that links logistics with sustainability. The selected articles focus on optimizing green supply chain design and planning, reverse logistics, the link between green supply chain and product design. Topics treated in this special issue are interesting both for academics and practitioners.

Nowadays, productive enterprises are facing increasing challenges to balance business performance and economic gains with environmental issues. In an age of increasing regulatory legislation for energy conservation and waste management, sustainability through green supply chains should not be a fad but a new discipline for strategic competitiveness.

“Green Supply Chain” (GSC) refers to the way in which organizational innovations and policies in supply chain management may be considered in the context of the sustainable environment. It involves different multiple objectives of social, economic and environmental sustainability.

Sustainability legislation, new consumer behaviour and the complexity of global trade are increasingly changing the way of designing and managing supply chains. In this context, one should take into consideration sustainability factors, such as minimization of carbon emission, treatment of reverse flows, optimization of energy consumption; etc., simultaneously with the product’s life cycle design and management of the supply chains.

The two first papers deal with strategic planning of green supply chain. « A generic model for network design including remanufacturing activities » by Mohammed Bennekrouf, Wassila Aggoune-Mtalaa and Zaki Sari focuses on the design of reverse logistics networks. In fact, reverse logistics aims at optimizing reverse product flows to limit residual waste. The main objective of the paper is to propose a comprehensive generic model that can help decision makers to design such networks that cover remanufacturing activities. This model aims also at helping devising strategies for the pricing of used and remanufactured products. More precisely a dynamic multi-commodity two level capacitated facility location problem for the green design of reverse logistic networks is presented. Therefore, both economical and ecological costs of reverse logistic activities are taken into account to help minimizing the damages of the reverse supply chain on the environment. Last, in order to better reflect real cases, this model includes fundamental features of reverse logistics which are overlooked in the literature, namely uncertainty in the products return, time dependency of the decision variables, capacity constraints and the possibility to treat multiple classes of products at a time.

Khaoula Besbes, Hamid Alloui, Gilles Goncalves and Taicir Loukil paper titled “A Green supply chain design with product life cycle considerations” deals with the design of green supply chain taking into account the product life cycle. The product life cycle here represents the unit sales for some product, extending from the time it is first placed on the market until it is removed. The evolution of product attributes and market characteristics through time, acts so as the product life cycle can be used prescriptively in the selection of marketing and planning. The product life cycle can be classified into four discrete stages: introduction, growth, maturity and decline. The integration of product lifecycle in the green supply chain design can provide fresh perspectives and critical insights that are often missed due to the extreme fragmentation of functions within the enterprise and across supply chains. This is the new frontier for value creation, an untapped area of opportunity to create competitive differentiation and growth for businesses on one side and on the other side to optimize the environmental impact for each period in the product life cycle. The procedure of selecting the supply chain actors and their environmental impact is strongly guided by the product life cycle. The interest of this paper is to emphasize the importance of taking into account the product life cycle in the green supply chain design, and suggest a two-phase approach to take it into consideration when designing the green supply chain.
The two following papers deal with tactical and operational planning of green supply chain. In the paper “Reusable containers management: From a generic model to an industrial case study”, Guillaume Goudenege, Chengbin Chu and Zied Jemai develop a generic model for reverse logistics management focused on reusable containers. This generic model should be adaptable to the specific requirements of a company (logistics network design, containers management rules...). After positioning the problem within the literature and explaining the approach, they briefly describe the developed generic model. Then, they focus on a precise and real life industrial application at a luxury goods company, describing their problematic, the tailored model as well as the results obtained both from economic and environmental points of view. As regards to the industrial application of this article, it is a project of studying the implementation of reusable containers within the supply chain of a company. The company’s objective is to invest and manage reusable containers at the lowest cost. But its actual objective is to remove (or reduce considerably) the cardboards currently used and which are not at all “green” behaviour and generate waste recycling. Scheduling strategies have historically emphasized lead-time; in almost all cases, energy and environmental factors have not been considered in scheduling.

The paper “Linear model for supply chain operational planning and carbon footprint optimization” by Frédéric Gautier, Philippe Lacomme, Pierre Pariente, Sylvèren Kemmoe-Tchomte and Nikolay Tchernev presents a new mathematical programming model of supply chain scheduling problem that considers CO2 emission and associated carbon footprint in addition to lead-time. To model the problem, authors chose the Job Shop theoretical model where each machine represents a supply chain member and jobs represent the product batches. The new model is demonstrated using a simple case study: a supply chain where two plants are employed to produce a variety of parts. They illustrate how carbon emission concerns could be integrated into operational decision-making with regard to production and to financial flows. The results show that carbon emissions across stages in a supply chain can constitute a significant threat that merits careful attention in the operational planning of supply chains.

The two last papers focus on the link between green supply chain and the product design. One issue of this link, which is modularity of product, is addressed in the paper “Product Modularity and Implications for the Reverse Supply Chain” by Gül Kremer, Junfeng Ma, Ming-Chuan Chiu and Tien-Kai Li. Modularity has been widely used and studied in both industry and academia. Modular products consist of detachable modules that can be manufactured, assembled, and serviced separately. Some module components (or overall modules themselves) can be reusable, recyclable, or remanufacturable after reaching the end of their original life cycle. The reverse supply chain represents all operations related to reuse of products, components and their materials. Recently, environmental issues including energy usage and the carbon footprint (CF) implications of products have attracted attention. Thus, designing product modular architectures that consider not only the interactions across components but also component end-of-life options (i.e., reuse, recycle, and disposal) has become important. In this paper, authors compare results of two modularity methods for their CF implications. The environmental impact (i.e., carbon footprint generation during assembly or manufacturing) was analysed by dissecting a refrigerator and using SimaPro software for the recovered data. Significantly, a new factor—the carbon footprint—is introduced into the analysis of modularization comparisons. They discuss the implications of the differences in carbon footprint for the reverse supply chain.

The concept of design for rebirth is discussed in the paper “Product Design for Rebirth: Application to Aircraft Life-Cycle Modeling” by Frédéric Gautier, Philippe Lacomme, Pierre Pariente, Sylvèren Kemmoe-Tchomte and Nikolay Tchernev, where a methodology of design for rebirth and green supply chain are simultaneously applied to an aircraft. When an aircraft will become obsolete, its owner wants to receive the highest possible value for it. Managing design for rebirth is a solution for manufacturers to find the economical and environmental best solution for an aircraft withdrawn from service. Data structure required is examined with a concurrent engineering approach. Rebirth is the global strategy of product analysis for product end-of-life (PEOL). This new methodology allows the product design according to objectives defined by its end of life and its generic engineering requirements, and this methodology is implemented in a framework. The data structure is based on topological information from a boundary representation (B-rep) model and it processes all information relative to the life cycle of the product. The software, based on this data structure, allows predefining certain characteristics based on knowledge of the company or on the database.

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