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## Designing Supply Chains with Sustainability Considerations \*

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### Abstract

Increasing regulatory legislations for carbon and waste management and the focus on corporate social responsibility are driving a major focus on supply chain sustainability. Sustainable Supply Chain Management involves different multiple objectives of social, economic and environmental sustainability. The current view is that there is a natural trade-off between the economic and the environmental dimensions. In this research, a goal programming model is proposed to address a supply chain design problem with environmental considerations. Carbon emissions (environmental dimension) and total logistics costs (economic dimension) are integrated at the supply chain supply design phase. The proposed methodology provides decision makers with the ability to understand the trade-off between total logistics costs and carbon reduction. It also allows offsetting the latter through both supply chain optimization and carbon-market based mechanisms. A crucial contribution of our work is that, together with incorporating regulatory environmental constraints such as emissions limits and costs/profit from carbon emissions, we comprehensively model compliance strategies for the supply chain including suppliers and sub-contractors selection, technology acquisition, and transportation modes configuration. The application of this approach is illustrated through a simple illustrative case study of well known Canadian firm. The latter operates in the steel industry and facing a new regulatory legislation that cap carbon emissions. The results obtained show that this approach is a viable decision tool and offer a good framework for sustainable supply chain design.

*Key words:* Supply Chain Management, Carbon Emissions, Multiple Objective Programming, Goal Programming

### 1 Introduction

Sulphur dioxide caps for electric utilities in the United States, regulatory carbon dioxide caps for companies across the European Union, and domestic regulatory framework for greenhouse gas (GHG) reduction in Canada and Australia, are only a few of the numerous regulations on air emissions that exist today. Corporations are realizing that GHG reduction strategies and sustainability policies are bottom-line issues. *Aberdeen Group* argues through a survey of 300 firms, world wide, that Corporate Social Responsibility (CSR) and Sustainable Supply Chain Management (SSCM) are on the top of the “green agenda” [1]. Their benchmark also demonstrates that 50% of them are planning to redesign their supply chain to be more sustainable and most importantly, almost 80% of them have to be in compliance with new environmental regulations. As a consequence, firms are facing new realities and need to consider different viable options and mechanisms to meet their legal obligations. Ideally, firms will reduce their emissions through sustainable actions such as the implementation of energy efficiency measures, the deployment of carbon capture and storage systems, or investing in other emissions reduction technologies. Also, companies can have access to other compliance mechanisms to earn carbon credits with the contribution to climate change technology fund or through an Emission Trading Scheme (ETS). ETS is based on a “cap-and-trade” approach where GHG emissions cap is enforced. Companies that reduce emissions

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