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Carbon Emissions Policies and its Impact on the Design of Supply Chains

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Carbon emission is a concern across the industry due to its environmental impact. In order to reduce carbon emissions, industry have to look not only at their processes but also in the generation of emissions in the whole supply chain that it belongs to. This is more necessary when various forms of carbon emissions policies are faced by the industry. The current focus on research is either in the economics of supply chain or mainly on the forward or reverse supply chains when it pertains to the carbon emissions. However, as lifecycle of the product is also becoming important, the isolated treatment of supply chains should be avoided for an integrated (forward and reverse) supply chain, also called the closed loop supply chain (CLSC). The complexity arises when the supply chain is faced with different kind of carbon policies implemented by the governments, for example, carbon tax, carbon cap, and carbon-cap and tax. The design of CLSC may change with the change in the carbon emission policy. In this research, a stochastic model is developed for the design of a CLSC by considering carbon emission policies. This work is one of the first attempts to understand the implication of carbon emission policy on the design of a CLSC. The model is applied to a sample case of aluminum industry with a life cycle assessment of emission.

Our preliminary findings include:

- (1) When the more scenarios are taken into account, the total cost and emission would increase, because more uncertain information is considered in CSSC design.
- (2) Given the same carbon cap, in a broad sense, the amount of emission credit traded in market changes in line with the total emission. It indicates that the emission trading is determined by the actual emission rather than the carbon price, even the uncertain carbon price is considered. However, a higher emission does not always lead to a bigger amount of emission to be traded.
- (3) The network structure obtained by the deterministic formulation is not able to be easily adapted to changes in demand and supply.

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- (4) In order to deal with the uncertain demand, the CLSC has to enlarge its handling capacity by using the facilities with a higher capacity or incorporating more facilities with the same function. With the same purpose, the supplier selection decisions are also changed associate the increasing scenarios.
- (5) The fuel of diesel is selected regardless of the scenarios. It means the current carbon price level would not motivate the firms to gain profit or reduce costs by employing future fuels in transportation. This conclusion is also proved by the further investigation when the total cost and emission are observed under decreasing cap. A further investigation reveals the transportation mode doesn't change when the carbon price increase from 9 to 234. Consequently, the future fuels would be attractive to firms only when the transportation price reduced or other policy environment changes, such as government subsidy. The efforts in reducing the transportation cost with future fuels have never ceased and the advanced technologies in automobile industry provide opportunity for green transportation promoters.