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A Decision Support Tool for Energy Efficient Synchromodal Supply Chains
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Abstract:
The industrial supply chain is a significant consumer of limited energy resources worldwide. Companies have been encouraged to reduce energy costs by restructuring their logistics network, improving their transportation asset fuel efficiency, and reducing travel distance. The recent evolution of synchromodal supply chains has focused on flexible transportation modes as a new option for supply chain managers to reduce the total energy cost. Illustrating the monetary advantages of such reconfigurations will guide decision makers to get the most from all available options.

In this paper, the process of modeling and developing a user-friendly, customizable tool for supply chain decision makers called the Synchromodal Supply Chain Energy Analysis tool (SySCEA) is presented. SySCEA enables the analysis of the overall environmental and economic effects due to supply chain fuel consumption and changing network configuration as it relates to order quantity, demand quantity, product size, packaging, mode and transportation assets. Currently, SySCEA supports up to five arc/routes, plus the first and last mile, for a synchromodal supply chain. However, due to the modular nature of the tool it is simple to extend it to larger networks.

Keywords: Energy measurement, Supply Chain, Transportation, Sustainable logistics, Decision support system, Synchromodal

1. Introduction
Supply chains are a primary user of energy worldwide. Environmental managers need to consider all supply chain issues from materials to energy in order to maximize system performance (Clift and Wright, 2000). Historically supply chain design has focused on minimizing costs or maximizing delivery performance. However, emphasis on environmental factors when designing the network has increased. Yet what environmental factors to consider and quantify is a question that needs to be answered. Full Life Cycle Assessment (LCA) of products that focuses on the measurement of manufacturing and distribution processes is one of the most common approaches to addressing and quantifying environmental factors. The LCA approach is computationally intensive, especially when the whole supply chain is considered. Another approach is to consider a partial LCA and model select processes from the product life cycle, e.g., one can solely focus on the calculation of Green House Gases (GHG) resulting from the transportation of products in a supply chain. A second approach is to calculate the carbon footprint, which is the most popular metric to measure environmental impact caused by a supply chain. Fuel consumption is a good predictor for estimating carbon footprint (Eskandarpour et al., 2015).

Decreasing the fuel consumption caused by the logistics and transportation of products in a supply chain is not only beneficial monetarily, but it also reduces emissions and the reliance on fossil fuel. In fact, companies should be encouraged to consider rebuilding their logistic networks in order to improve the fuel efficiency of their transportation assets. The shipping of goods involves multiple corporate entities and the complexity of the overall supply chain requires suppliers and transport providers to look for ways to decrease costs, maximize energy efficiency, and plan for a more sustainable, greener future.

Multimodal transportation has great potential for improving the environmental performance of freight transportation, but typically supply chains rely on a single mode and the decision maker does not have the

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