

## Chapter 19

# Multi-Objective Optimization for Green Dual-Channel Supply Chain Network Design Considering Transportation Mode Selection

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### ABSTRACT

*A well-designed supply chain network should not only meet the efficient cost but also realize the sustainable effect on environment. The purpose of this article is to develop a multi-objective model to capture the trade-off between total cost and environmental performance in the green dual-channel supply chain network. Moreover, the transportation mode has been considered as a decision variable. With regard to the complexity of such network, a new swarm intelligence algorithm known as a multi-objective particle swarm optimization (MOPSO) algorithm has been employed to tackle this problem. The effectiveness of the present model and approach is evaluated by a numerical experiment, and the results show that the added environmental performance is actually proportional with the increased cost. Additionally, the comparison between different mode decisions shows that a better trade-off between two objectives will be obtained when considering the transportation mode selection.*

## **INTRODUCTION**

Today's business world is highly competitive. The competition between enterprises always means the comparison in their supply chain. In order to take the dominated role in the market, the firms should pay more attention to the design of supply chain network. Generally, the supply chain consists of the manufacturers, warehouse centers, distribution centers and the end users. Moreover, the determinations of suitable numbers, right locations, reasonable capacities of facilities and appropriate flow of goods through the network are also the responsibility of the supply chain management (Shankar, Basavara-jappa, Chen, & Kadadevaramath, 2013). It is obvious that a well-designed supply chain network can fundamentally improve the operational efficiency of the whole chain and achieve the maximum benefit with minimum investment (Gumus, Guneri, & Keles, 2009). Different models are applied to optimize these network designs, including linear (Romeijn, Shu & Teo, 2007) and nonlinear (Santoso, Ahmed, Goetschalckx, & Shapiro, 2004). Based on the feature of the problem studied in this paper, the authors apply a linear mode for the supply chain network design.

Over the last decade, the environmental problems such as greenhouse effect, air pollution, high sea level and the global warming have aroused the worldwide awareness of protecting environment. Thus, the green principles are applied by some organizations to take the responsibility of environment. The first application of green principles in supply chain is Markovits-Somogyi et al. (2009), who raises the conception of green supply chain. Additionally, a detailed review on green supply chain management has been presented by Min and Kim (2012) which contains over five hundred papers. The environmental concerns in supply chain network have been one of the important conditions for companies to achieve long-term stable development. More and more studies on green supply chains network design have been published (An, 2008; Bai & Sarkis, 2010; Ko, Tseng, Yin, & Huang, 2008; Yeh & Chuang, 2011). In fact, with the rapid development of information technology, the customers purchase products not only from the distribution centers which are known as the traditional channels, but also from the manufacturers which are defined as the e-commerce channels (Xu, Liu, & Zhang, 2012). As a result, most of the manufactures open the online channel to attract more customers (Xu et al., 2012). Nearly 42% of the top enterprises including the Dell, Hewlett-Packard, Estee Lauder, Nike and Apple have created the e-commerce channel for customers according to the researches of Tsay and Agrawal (2004) and Liu et al. (2010). Therefore, the structure of supply chain network is changed from single-channel to dual-channel. However, previous researches on green supply chain network design mainly aimed at single-channel problems. Much more investigations on green dual-channel supply chain network design are needed.

With respect to environment, the transportation activity is the most pivotal part of supply chain network. In accordance with the discussion of Dekker et al. (2011), the carbon emissions caused by transportation are almost 14% of the whole emissions. Hence, the fundamental task of improving the green level in supply chain network is to enhance the environmental performance of transportation (Azizi, Yarmohammadi, Yasini, & Sadeghifard, 2015). To select the transportation mode properly is one of the main methods to realize the environment-friendly transportation. Nevertheless, few literatures have seen the determination of transport mode as a tactical decision (Khalifehzadeh, Seifbarghy, & Naderi, 2014; Le & Lee, 2013; Rajabalipour Cheshmehgaz, Islam, & Desa, 2014). Based on the mathematical research model built by Dekker et al. (2011) for choosing transport mode, the researchers consider the selection of transportation mode as a decision variable in our model to narrow the gaps. In particular, the influences of different mode decisions on the performance of supply chain have been investigated.

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