Chapter 19
A Closed-Loop Logistics Model for Green Supply Chain Management

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ABSTRACT

Recently, with the environmental crisis, Green supply chain management (or GSCM), and in particular closed loop supply chain model, has received considerable attention by researchers. Closed loop supply chain model aims at reduction of waste and generating profit for enterprises through integrating forward and reverse logistics. Unfortunately, there is limited research on general models for closed loop supply chains in literature. In this paper, extending and enhancing previous models, a general model is proposed for closed loop supply chains using linear programming. The goal of this study is to minimize the leakage of a closed loop supply chain to avoid waste and reduce SCM costs.

INTRODUCTION

A supply chain is a network of facilities and distribution options that has the responsibility of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers (Kaihara, 2003). Soroor et al. (2009) examined critical failure factors of supply chain logistics and the results show that information sharing plays the most critical role in its success.

Recently due to awareness of environmental protection, wasting fewer materials by reusing and remanufacturing the used products has been an issue for enterprise. This made manufacturers to move toward green supply chain management. In spite of conventional supply chain management, green supply chain management demands

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recycling and a closed-loop logistic is necessary for material flow within supply chains. To make it clearer supply chain models could be categorized as follows:

Forward Supply Chain

A forward supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers.

Reverse Supply Chain

A reverse supply chain focuses on the backward flow of materials from customers to suppliers (or alternate disposition) with the goals of optimizing supply chain efficiency in terms of value from returned items and reverse logistics costs. A well-managed reverse logistics programme can provide cost savings in procurement, disposal, inventory carrying and transportation (Kannan et al., 2009). Rogers and Tibben-Lembke (1999) define reverse logistics as "the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal". In this process low transaction costs are vital for acquiring products at the end of their life (Morana & Seuring 2007). Reverse distribution can take place through the original forward channel, through a separate reverse channel, or through combinations of both forward and reverse channel. Rubio et al. (2008) have extensively reviewed the research works in this concept.

Closed Loop Supply Chain

A closed loop supply chain model consists of both the forward supply chain, and the reverse supply chain. The forward supply chain essentially involves the movement of goods/products from the upstream suppliers to the downstream customers. The reverse supply chain involves the movement of used/unsold products from the customer to the upstream supply chain, for possible recycling and reuses. The reverse supply chain should be a part of forward supply chain integrated, as it can contribute to lowering overall costs and meeting governmental/environmental regulations. There are different sources of uncertainty in this process. Huang et al. (2009) has mentioned closed-loop supply chain uncertain operations and production control by analysing and establishing a class of dynamic closed-loop supply chain models of linear discrete time system, including the product return model, the re-manufacturing model and the third party reverse logistic providers (3PRLP) collecting model.

Closed loop supply chain has gained an extensive importance today, in the world of increasing environmental concerns and strict regulations on the wastage caused right from inception of a product, through its life period and after it. Closing the loop helps manufactures to decrease the undesirable environmental footprint of supply chains (Quariguasi Frota Neto et al., 2010). One striking example is that several industrial countries in Europe have enforced environmental legislation charging manufactures with the responsibility for reverse logistics flows, including used products and manufacturing-induced wastes (Robeson et al., 1992; Fleischmann et al., 2000). In addition, global enterprises, e.g., IBM, Hewlett–Packard, Xerox, have increasingly undertaken measures, including the integration of corresponding suppliers, distributors, and reclamation facilities in order to green their supply chains (Ashley, 1993; Bergstrom, 1993; Maxie, 1994). This inclusion has also brought significant challenges even to Asian enterprises such as overcoming green barriers and increasing their international competitive ability. For example, Bristol-Myers Squibb, IBM and Xerox have encouraged their Chinese suppliers