The retrofit of a closed-loop distribution network: the case of lead batteries

Ana Serra Fernandes\textsuperscript{a}, Maria Isabel Gomes-Salema\textsuperscript{b}, Ana Paula Barbosa-Povoa\textsuperscript{a},

\textsuperscript{a}Centre for Management Studies, CEG-IST, UTL, Av. Rovisco Pais, 1049-101 Lisboa, Portugal, apovoa@ist.utl.pt

\textsuperscript{b}Centro de Matematica e Aplicacoes, FCT, Universidade Nova de Lisboa, Monte de Caparica, 2825-114 Caparica, Portugal, mirg@fct.unl.pt

Abstract

Recent advances in global competition with the exhaustion of natural resources, and the increased society awareness towards environment created a new way of thinking when managing supply chains. Companies are now facing the need of seriously considering within their supply chain the presence of their end-of-life products. The concept of closed-loop supply chains has emerged where optimized structures are required. In this paper the design and planning of a real closed-loop supply chain is studied considering the production of lead batteries its distribution to the final clients and its collection at the end-of-life period. The company with a wide distribution network, at Portugal level, and a fleet of owned vehicles reached effectiveness in the delivery service to the final costumer. It is now vital to reach efficiency at costs level. To help reaching this goal the present work looks into the retrofit of the existing structure so as to achieve the optimized design of the closed-loop supply chain. A Mixed Integer Linear Programming (MILP) model is developed which simultaneously designs the forward and reverse chains. Various scenarios are built from which decisions regarding the retrofit of the existing network (namely, elimination, addition and replacement of warehouses) are obtained with a significant reduction of costs. The contemplated costs are: the cost of opening warehouses, the cost of the raw materials acquire to suppliers and of used products acquire to customers, as well as the cost of the different transportation resources. Besides strategic design, plans of supply, production, storage and transportation are also given by the model. The results obtained are compared with the existing network and important conclusions are drawn.

Keywords: Closed-loop Supply chain, Retrofit, Network design, Network Planning.

1. Introduction

Today companies, to remain competitive, have to provide a good service with very short delivery times and, simultaneously, at the lowest possible cost. To respond to the challenge of cost reduction and service enhancement, companies need to take a close look into the design and planning of their supply chain. Such logistics systems are however quite complex, especially when the recovery of end-of-life products is also at stake. So, it is difficult to take good decisions without the use of efficient tools to help