Design and Planning of Supply Chains with Reverse Flows

Maria Isabel Gomes Salema\(^a\), Ana Paula Barbosa Póvoa\(^b\), Augusto Q. Novais\(^c\)

\(^a\)CMA, FCT, UNL, Monte de Caparica, 2825-114 Caparica, Portugal
\(^b\)CEG-IST, Av. Rovisco Pais, 1049-101 Lisboa, Portugal
\(^c\)DMS, INETI, Est. do Paço do Lumiar, 1649-038 Lisboa, Portugal

Abstract
A multi-product model for the design of global supply chains with reverse flows is proposed. Two levels of decisions are considered, one strategic and one tactical. The first is modelled through a macro perspective of time where the determination of the network structure and flows is accomplished. At tactical level, a micro perspective of time is considered, where production planning and inventory management are addressed in detail. A mixed integer linear programming formulation is developed which is solved with standard Branch and Bound techniques. The model accuracy and suitability are studied using a case study.

Keywords: Supply Chain design, Optimization, Reverse Logistics, Planning.

1. Introduction
In modern society, used products constitute a major challenge. Governments are facing overflowed landfills, while creating legislation to shift product management responsibility towards the producers. Used/disposed products are now placed in a different perspective, as company managers perceive new business opportunities whereby these products should be returned to factories for remanufacturing/recycling. Consequently, the supply chain must be extended and no longer terminate at the end customers, but account also for the products return.

Only recently the scientific community started looking into this problem. Thus the reverse logistics problem appears as an emerging field where only a limited number of models have been, so far, presented in the literature. These are essentially case study dependent and mostly consider the reverse flow on its own and not as an integral part of the supply chain. As the most generalized published models, one should refer to: Fleischmann et al. (2001), where forward and reverse flows of a given product are integrated, with no limiting capacities in the involved facilities and flows; Jayaraman et al. (2003), who proposed a MILP model for the reverse distribution problem, without taking into account the forward flow; Fandel and Stammen (2004), that proposed a MILP general model for extended strategic supply chain management, based on a two-step time structure, but where no testing of adequacy to any example/case was explored; and finally Salema et al. (2004) who developed a capacitated multi-product design

\[^{v}\] Author to whom correspondence should be addressed, apovoa@ist.utl.pt