# The value of information in a container collection system for end-of-life vehicles

Ieke le Blanc [1], Rene Schreurs [2], Hein Fleuren [1], Harold Krikke [1]

[1] CentER Applied Research, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands
[2] Auto Recycling Nederland, P.O. Box 12252, 1100 AG Amsterdam Zuidoost, The Netherlands

**Abstract** In this paper we discuss the value of accurate inventory information for distribution planning purposes in a reverse logistics system. Three levels of information are introduced and the value is assessed in a simulation loop. For every planning period the operational vehicle routing problem is solved to optimality by route enumeration and set partitioning. Extensive sensitivity analysis is performed and discussed to analyze the factors that influence the value of accurate inventory information for reverse distribution planning. Network density appears to be one of the main determinants.

## 1. Introduction

### 1.1 Reverse logistics and uncertainty

Reverse logistics is the management of good flows in the opposite direction of the traditional supply chain, with the purpose of value recovery or proper disposal (Rogers and Tibben-Lembke 1998). Products can be returned at several stages of their life cycle as so-called commercial, repairable, end-of-use or end-of-life returns. The complexity of reverse logistics management is largely caused by uncertainty (Fleischmann et al. 2000). Uncertainty in the behavior of the system is caused by the lack of information and control mechanisms regarding quantity, timing, product compositions and quality of returns. Uncertainty and the type of return are among the major determinants of the right reverse supply chain (Krikke et al. 2004). Within the right logistic network design, the application of modern sensor technology can help in reducing and managing the uncertainty. Examples in reverse logistics are the application of so-called "data-logs" in power-tools (Klausner and Hendrickson 2000) or sensors embedded in cars and car tires (Van Nunen and Zuidwijk 2004). These applications reduce the complexity in foreseeing when the return occurs, the handling of the returns or the selection of the appropriate recovery option. Here we focus on returns of end-of-life products,

where material recycling is the appropriate disposition option. Recovery processes in these networks are typically centralized, resulting in relative high transportation cost for these low valued recyclables.

In forward logistics, inventory management and control is common practice. Real-time stock information has become the standard. In reverse logistics, the stocks of cores or recyclables are often disregarded and no registration exists at all. If a certain amount of recyclables is available at a collection point, transfer to a centralized facility takes place. The lack of information about the stock size at the collection sites makes it impossible to plan collection trips ahead. Ultimately, inventory and routing decisions should be taken simultaneously (Herer and Levy 1997). A research on the collection of liquids coming from end-of-life vehicles showed opportunities for significant cost savings in a network with low density (Le Blanc et al. 2004). In this research, based on a real-life case study in the Netherlands, we focus on the value of inventory information for the collection planning of containers for various network densities.

## 1.2 Background case study

The study presented in this paper is performed for Auto Recycling Nederland (ARN). ARN is an organization coordinating the recycling of end-of-life vehicles (ELVs) in the Netherlands on behalf of the automotive industry. Existing ELV-dismantlers, logistic service providers (LSPs) and recyclers carry out the work for ARN on a commercial basis, recycling over 275,000 wrecks yearly. High volume materials dismantled from ELVs such as PU-foam, rubber, glass, tires and bumpers are stored and collected in containers. When a container is full, the ELV dismantler places a request at the LSP to collect the container. Within 5 working days, the LSP visits the dismantlers and exchanges the full container for an empty one. The containers are brought to a depot where some processing takes place. Afterwards, they are sent to the recyclers in consolidated batches. Figure 1 gives an overview of the system. Yearly, approximately 5,000 containers are collected in this manner in the ARN system. The collection of containers concerns about 70% of the total collection cost incurred by ARN. Research has shown that, in the earlier mentioned collection system for oils and fuels, the cost of collection can be reduced significantly by knowledge of accurate stock levels at the ELV-dismantlers. The goal of this research is to examine the possibilities to extend these results to the collection system of containers.