Int. J. of Sustainable Water and Environmental Systems
Volume 3, No. 1 (2011) 5-11

Network Design for End of Life Vehicles Recovery in Countries with Developing Economy

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Abstract

This paper aims at establishing a visible and traceable system for recovering End of Life Vehicles (ELVs) in a sustainable manner. The target is to cease the inefficient and scattered practices associated with ELVs, and simultaneously enhance the recycling and reuse activities and implementing life cycle management practices in regions with developing economies and labor intensive aspect. To tackle this problem a mixed integer linear goal programming (MILGP) model is developed. The solution of the model helps deciding on the location of the recovery facilities in addition to the number of parts and assemblies headed to different End of Life (EOL) options. The effect of the model parameters on the network design is examined. The results may be used as a guide in setting recovery targets and environmental regulations controlling the activities of ELVs treatment.

***Keywords**: Recovery Network Design, End of Life Vehicles, Sustainability, Goal Programming, Reverse Logistics*

1. Introduction

The consideration of the whole life cycle of a product from cradle to grave, initiated new goals and constraints for the recovery network design problem. The objective is extending the useful life of the product and recovering material and energy after it has performed its tasks. To achieve this goal, a reverse flow of products rises from the customer backward to the original manufacturer. New activities are created for dealing with the reverse flow as well as new echelons, namely the recovery centers.

Activities differentiating reverse logistics from traditional distribution networks are present in different centers such as the collection, the inspection, the sorting, the disassembly, the re-distribution, and the disposal ones. Multiple case studies, presented in previous work, dealt with the life cycle thinking and the sustainability in diverse fields among them are the automotive industry [1] and [2], the electric appliances industry [3] and [4], the paper recycling [5], and the cellular phones [6].

The importance and increasing interest and concern about the recovery of end of life vehicles (ELV) is manifested through the numerous legislations controlling this field. The Directive 2000/53/EC in the European Union and Statue 307 in China are examples of acts regulating the recovery process of ELVs worldwide. The reason for this concern is twofold. First, the huge amount of vehicles currently produced means a huge amount of material sent to landfill after the vehicle passes its usage phase, which is a problem with regard to the ever shrinking landfill capacity. Second, the high metal content in the vehicle makes it an attractive source of raw material recovery and links it to other metal production industries.

The composition of an average car manufactured in 1985 is given in Figure 1. It is well clear that the percentage of ferrous metals is relatively high in comparison with the other materials. The main activities performed in an ELV recovery network are disassembly and shredding. The disassembly consists of three steps. First, the vehicle is drained from its operating fluids. Second, easy removable exterior and interior parts are separated. The final step consists of dismantling the engine, the transmission mechanism, and the axles. Once dismantled the car is compacted and sent through a shredder. The material is magnetically segregated into ferrous materials, sold later to steel mills and non-ferrous materials, mainly Aluminum and Copper. The remaining amount constitutes the Automobile Shredder Residue (ASR) and is disposed of. ASR consists of a mix of plastics, fluids, and other metals and can pose a disposal problem. ASR can sometimes reach as much as 25 percent of the total weight of the car [8].

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DOI: 10.5383/swes.03.01.002