Chapter 11

SIMPLE PLANT LOCATION PROBLEM WITH REVERSE FLOWS

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Abstract: We analyze the characteristics of the logistics systems including both direct and reverse flows, their activities and structure. We address the strategic planning problem of such systems and propose a facility location model as an extension of the simple plant location problem while taking into account the specific constraints related to reverse flows of directly reusable items. For solving this model, an algorithm based on lagrangian heuristics is developed. Numerical experiments are presented and the influence of reverse flows on the number and location of facilities is discussed. Extensions to this research are also proposed.

Key words: logistics, reverse logistics, facility location, lagrangian relaxation.

1. BASIC CONCEPTS OF REVERSE LOGISTICS

Complying with the changes in legislation, and protecting environment as well as economic and service reasons, more and more enterprises now take into account the reverse flows going backwards from customers to manufacturing plants or distribution centers within their logistics systems [17, 8] and a new domain is emerged - Reverse Logistics (RL). In fact, reverse logistics is not only the requirement of mitigating the burden on the environment, but a measure of improving the competence of enterprises and customer service level, and reducing the production costs [12]. However, little research work has been up to now devoted to this domain, particularly to the planning and optimization of reverse logistics systems.
We define reverse logistics as follows: “Reverse logistics can be viewed as an evolution of traditional forward logistics under environmentally-conscious industry or by other commercial drives. It encompasses all the logistics activities and management functions for reintroducing valued-objects, which finish or are not suitable to perform its primary function any more, into recovery systems for either recapturing their value or proper disposal”. 

A RL system comprises a series of activities, which form a continuous process to treat return-products until they are properly recovered or disposed of. According to industrial practices, a RL network may include some or all of the following activities: collection, cleaning, disassembly, test and sorting, storage, transport, and recovery operations. And this last activity can also be represented as one or a combination of several main forms, like reuse, repair, refurbishing, remanufacturing, cannibalization and recycling [2, 21, 6].

Figure 11-1 proposes a general representation of logistics systems with reverse flows, in which we can find two opposite directions of flows: the forward flow, consisting of initial products, flow from producers to customers and the reverse flow, constituted of the return-objects, from customers to recovery centers. Possible activities/stages concerning the forward and reverse channels have also been indicated in such a combined system.

![Figure 11-1. A framework of logistics systems with reverse flows](image)

For the purpose of planning system activities, two elements are very important in order to facilitate the identification of the system characteristics: the type of return items and the main options adopted by the system for recovery. According to [7, 22], three principal types of return-items can be distinguished: packages, rotatable spare parts and consumer goods; and four principal options of recovery can be categorized: reuse, repair, recycling and remanufacturing. Based on these two elements, four kinds of typical RL networks can be classified as follows:

- Directly Reusable Network (DRN). The return-objects consisting of the reverse flows in this network can be directly reused or need only a little