Chapter 2.8
Reverse Supply Chain Design:
A Neural Network Approach

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ABSTRACT

The success of a reverse supply chain heavily relies on the efficiency of the collection facilities and recovery facilities chosen while designing that reverse supply chain. In this chapter, we propose a neural network approach to evaluate the efficiency of a facility (collection or recovery) of interest, which is being considered for inclusion in a reverse supply chain, using the available linguistic data of facilities that already exist in the reverse supply chain. The approach is carried out in four phases, as follows: In phase I, we identify criteria for evaluation of the facility of interest, for each group participating in the reverse supply chain. Then, in phase II, we use fuzzy ratings of already existing facilities to construct a neural network that gives impacts (importance values) of criteria identified for each group in phase I. Then, in phase III, using the impacts obtained in phase II, we employ a fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) approach to obtain the overall rating of the facility of interest, as calculated by each group. Finally, in phase IV, we employ Borda's choice rule to calculate the maximized consensus (among the groups considered) rating of the facility of interest.

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MOTIVATION

Although companies tend to spend more time and money in fine-tuning their forward supply chains, in today's competitive business environment, they can no longer ignore reverse supply chains due to the two most important factors, viz., environmental regulations and profitability (Fleischmann, 2001; Gungor & Gupta, 1999). A reverse supply chain, which is the series of activities required to retrieve used products from consumers and either recover their left-over market values or dispose of them, utilizes at least the following (see Figure 1): *collection facilities* where used products are collected, *recovery facilities* where reprocessing, viz., disassembly, remanufacturing, or recycling, are performed, and *demand centers* where re-processed goods are sold. Evidently, the success of a reverse supply chain heavily relies on the efficiency of the collection facilities and the recovery facilities chosen while designing (also called strategic planning) of that reverse supply chain.

The efficiency of a collection or recovery facility depends on the participation (in the reverse supply chain) of three different groups who have multiple, conflicting, and incommensurate goals, as follows:

1. *Consumers* whose primary concern is *convenience*,
2. *Local government officials* whose primary concern is *environmental consciousness*, and
3. *Supply chain company executives* whose primary concern is *profit*.

Therefore, the evaluation of a facility must be based upon the maximized consensus among the three groups.

In this chapter, we propose a neural network approach to evaluate the efficiency of a facility (collection or recovery) of interest, which is being considered for inclusion in a reverse supply chain, using the available *linguistic* data of facilities that already exist in the reverse supply chain. The approach is carried out in four phases, as follows: In phase I, we identify criteria for evaluating the efficiency of the facility of interest, for each group participating in the reverse supply chain. Then, in phase II, we use fuzzy ratings (Zadeh, 1965) of existing facilities to construct a neural network that gives impacts (importance values) of criteria identified for each group in phase I. Then, in phase III, using the impacts obtained in phase II, we employ a fuzzy TOPSIS approach (Chu, 2002), that is, a combination of the fuzzy set theory (Zadeh, 1965) and the TOPSIS (Technique for Order Preference by Similarity to Ideal Solution; Triantaphyllou & Lin, 1996), to obtain the overall rating of the facility of interest, as calculated for each group. Finally, in phase IV, we employ Borda's choice rule (Hwang, 1987) to calculate the maximized consensus (among the groups considered) rating of the facility of interest.

In the next section, we review a few important papers in the literature, which propose models to design a reverse supply chain. Then, we briefly introduce the techniques, viz., the fuzzy set theory, the TOPSIS, and the Borda's choice rule used in our approach, and present the approach to evaluate the efficiency of a collection facility of interest.

Figure 1. A generic reverse supply chain network