ABSTRACT

In this research work, three major issues of reverse supply chain management, namely, design options for integrated forward and reverse networks with reference to optimal location of facilities, performance evaluation of these network configurations and incentive issues related to flow of product in the network are considered.

The objectives of this research work are to identify and evaluate all possible configurations of integrated networks, for optimal location of facilities and allocation of demand, evaluate the performance of the selected networks in terms of flow time, and inventory and study the impact of incentive system on the volume of used product returns in reverse supply chain networks. A system study of an organization, which is manufacturing and marketing automotive batteries was considered to assist the research.

The first part of the study focuses on developing different hypothetical network configurations for both forward and reverse supply chain networks. Four different configurations were developed and evaluated using mixed integer linear programming (MILP) models to select appropriate number and locations of franchisees, warehouses and smelters and to estimate network cost. These four configurations are Config-1 (Optimized existing network), Config-2 (independent collection and storage network), Config-3 and Config-4 (integrated hypothetical network of both forward flow of new
batteries and reverse flow of used batteries). All the above referred four network configurations are compared based on cost and suitable network configuration was suggested for implementation.

The second part of the study focuses on performance modeling of supply chain networks. For this purpose, the existing supply chain networks as well as proposed optimized network were modeled as queuing networks with each stage of the network represented by associated service nodes. A simulation approach was used to evaluate the performance of these supply chain queuing networks.

The simulated values of performance measures of mean flow time and mean stock for each stage of the networks were estimated. This supply chain network simulation model was used to conduct the different categories of simulation experiments to study the performance of the network. The reverse network was simulated to study the impact of inventory policies at two stages of the network, namely franchisee and warehouse.

The third part of the study focuses on a system dynamic model which was developed to capture the policy issues of incentives and returns of the used batteries, the price offered by unauthorized smelters and to find out their impact on performance of reverse supply chain network. As a part of system dynamic model, the causal loop diagram and stock and flow diagram were developed using observed data. The model was simulated using VENSIM software and the results are presented. A few experiments were conducted with the systems dynamics model by varying different parameters.
and results were studied. The model also recommends some important policy decisions that the manufacturer should implement with respect to ‘Price adjustment time’, ‘Time to return’ and ‘Buyback price’.

The major contributions of the research work are different network configurations were studied for minimum cost while identifying the associated facilities namely warehouses, franchisees and smelters in the network. This study describes design and development of a four-stage supply chain network, consisting of a manufacturing plant, group of warehouses, a set of franchisees for each location and selected recycling plants. Development of queuing network model for the supply chain network facilities and incorporating combination of pull and push supply chain concepts in the simulation model of the supply chain network. The research work provides policy guidelines in terms of inventory policies for reverse flow of products. The research work also provides policy guidelines in terms of appropriate incentive policies to improve the volume of used product collection from customers and retailers.