SYNOPSIS

Determining the optimum number of suppliers and the optimum quantities to order from each of them is a critical problem for any supply chain. In reality, the manufacturing firms collect the raw materials from number of suppliers, process them to build end product(s) and sell the end products to the customers. In a retail context, when the firms involve only in buying, storing and selling of a product, the emphasis on the sourcing policy of the firm becomes more prominent, because one of the major ways of increasing the profit for the retail firms is by improving its supply and inventory management. That is the reason why retail firms like Wal-Mart, K-Mart, Amazon, Big Bazaar, Auchan spend a lot of effort on their supply management.

Over the period of time, researchers have developed several inventory models in the retail context to optimize the retailers’ sourcing and inventory policies. To comply with reality, the researchers have assumed stochastic demand and supply to incorporate environmental uncertainty into the models. However, these researches were mostly confined to a single period. Since identifying the optimal sourcing strategy for a firm is a part of its aggregate planning, a single period model cannot aid the manager in making the right decision. Also, most of the past researchers in the area considered either a single supplier situation or a dual supplier situation. In reality, a retailer has the option of multiple suppliers with different costs and reliabilities. Therefore, there is a need to develop a comprehensive mathematical model which includes demand uncertainty, supply uncertainty, multiple suppliers with different costs and reliabilities and multiple periods.

In this study, in line with the assumptions of the past researchers, the firm is assumed to be a trading firm involved in buying and selling a single product. There are multiple suppliers each
quoting a specific price per unit. The lead times of the suppliers are assumed to be same and constant. The reliability of the suppliers are assumed to be different, the yields of the suppliers being stochastic. Also, existence of a back-up supplier, who can supply the product in case of emergency when there is a mismatch between demand and supply is assumed as was done by Kouvelis and Li (2008). This is not an unrealistic assumption, as firms tend to keep back-up suppliers for emergency situations. For example, Toyota has Aisin Seiki Co. as the regular supplier for the P-valves, and Somic Ishikawa Inc. as the back-up supplier for the same raw material. This practice helped Toyota in overcoming the emergency situation in 1997, when a fire broke out at Aisin Seiki Co. The reliability of the back-up supplier is assumed to be 100%. However, the cost quoted by the back-up supplier is higher than the cost quoted by the regular suppliers. Orders for supply are placed for each period. The maximum amount to be supplied by the back-up supplier is to be decided at the beginning of each period. Also, the back-up supplier charges a portion of the cost for booking the amount at the beginning of the period.

The demand for the product is assumed to be stochastic and backlogging of unsatisfied demand is allowed at a cost. Inventory holding costs are also considered. A mathematical model is developed for which the objective is the maximization of the expected total profit. The decision variables are the order quantities for each supplier. Relevant constraints like non-negativity of the decision variables and capacity constraint of the back-up supplier is developed.

First, a solution for single period model is obtained and then it is extended to multiple periods. For the single period model, unmet demand is assumed to be lost and excess inventory at the end of the period is sold at scrap value. Under the assumption of uniformly distributed demand, a closed form solution is obtained.
Single period model is then extended to the multi-period context. It is assumed that unmet demand is backlogged and excess inventory at the end of a period is carried to the next period. For infinite time horizon scenario, closed form analytical solution is obtained for uniformly distributed demand per period. For finite time horizon model, dynamic programming approach is used to obtain a solution to the problem.

Sensitivity analysis was carried out to examine the sensitivity of the solution for changes in input parameters: price of the product, penalty cost faced by the firm for not meeting the demand, inventory holding cost, salvage value of the product, reliability of the suppliers. The sensitivity plots are obtained for both single and multiple period scenarios.

The implications and the contributions of the study are identified. Suggestions for directions for future research are also given.