Chapter V
Computational Intelligence Approach on a Deterministic Production-Inventory Control Model with Shortages

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ABSTRACT

Here, an attempt has been made to determine an optimal solution of a deterministic production-inventory model that consists of single deteriorating items and a constant rate of deterioration. In this proposed production-inventory model, lead time is taken to be negligible and demand rate is a ramp type function of time. Shortages are allowed and partially backlogged. During this shortage period, the backlogging rate is a variable which depends on the length of the waiting time over the replenishment period. Mathematical formulation of the problem highlighted the model as a complex nonlinear constrained optimization problem. Considering the complexities towards solution, modified real-coded genetic algorithms (elitist modified real coded genetic algorithm [MRCGA]) with ranking selection, whole arithmetic crossover, and nonuniform mutation on the age of the population has been developed. The proposed production-inventory model has been solved via MRCGA and simulated annealing and as well as standard optimization methods. Finally, the results are embedded with numerical example and sensitivity analysis of the optimal solution with respect to the different parameters of the system is carried out.

INTRODUCTION

In production-inventory management model, it is observed by the management scientists that the deterioration of an item plays a pertinent role in mathematical modeling and computation. With fluctuating nature of demand of end users', stock of items continuously decreases due to deterioration effect. Many commonly used items which are either damaged or decayed are not in a perfect up-to-date condition to satisfy the time varying and conflicting nature of demand of customer. This deterioration effect depends on preserving facility and environmental condition of warehouse/storage. As a result, this effect cannot be directly ignored from comprehensive analysis of the production-inventory model.

Recently, a number of mathematical models have been highlighted in the literature for estimating order quantity for deteriorating items (Ghare & Schrader, 1963). They first pointed out that the inventory is depleted not only by demand but also by decay (direct spoilage or physical depletion). They formulated an inventory model for exponentially decreasing inventory and constant rate of demand. Shah and Jaiswal (1997) developed an order-level inventory model for deteriorating items with a constant rate of deterioration. After that, Aggarwal (1978) formulated the same by correcting and modifying the errors in Shah and Jaiswal's analysis in calculating the average inventory holding cost.

In most of the inventory models, the demand rate is considered to be either constant or time-dependent but independent of the stock status. However, in the present market scenario, customers are influenced by the marketing policies-like attractive display of units in the market/business firm. Items like fruits, vegetables, fashionable commodities, and so forth and displays of those units in huge numbers has a motivational effect on people to buy more; demand is influenced by stock status, termed as stock dependent demand.

Again, inventory problems with deterministic time dependent demand patterns gain serious attention to several researchers. Demand of this type directly affects the sales volume in different phases of product life cycle. Again, demand for inventory items shows a conflicting in nature: it increases with time in growth phase and decreases in the decline phase. Donaldson (1977) first developed an inventory model with a linearly increasing time dependent demand rate over a finite planning horizon. After Donaldson, several researchers, such as Goyal and Aggarwal (1981), Giri, Goswami, and Chaudhuri (1996), Bhunia and Maiti (2001), and many more have developed this type of model by incorporating a time varying demand rate into their models for deteriorating and nondeteriorating items with or without shortages. But dealing with this type of complex analysis, management scientists are not always successfully implementing the traditional optimization methodologies for solving such a model; advanced methods are required to search for solving these complicated mathematical models.

In management science, dealings with decision making problems, generally with the traditional direct and gradient-based optimization methods, (conjugate gradient methods like Fletcher-Reeves, Polak-Ribiere, etc., and Quasi-Newton methods like Davidson-Fletcher-Powell, Broyden-Fletcher-Goldfarb-Shanno, etc.) are used for computation to get "optimal" or "near optimal" solution. But these methods do not process towards achieving reasonable solutions for difficult combinatorial mathematical optimization problems. Again, these methods are:

1. Dependent only on initial solution, are not universal; rather problem dependent.
2. Are getting trapped at a "local" optimum,
3. are not judiciously reducing the search space.
4. Are not amenable to parallel processing, that is, investigation of different solution sequences can not be done in parallel.

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