A Fuzzy Inventory Model for Weibull Deteriorating Items with Price-Dependent Demand and Shortages under Permissible Delay in Payment

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ABSTRACT

In this paper, a fuzzy inventory model is formulated for deteriorating items with price dependent demand under the consideration of permissible delay in payment. A two parameter Weibull distribution is taken to represent the time to deterioration. Shortages are allowed and completely backlogged. For fuzzification of the model, the demand rate, holding cost, unit purchase cost, deterioration rate, ordering cost, shortage cost, interest earned and interest paid are assumed to be triangular fuzzy numbers. As a result, the profit function will be derived in fuzzy sense in order to obtain the optimal stock-in period, cycle length and the selling price. The graded mean integration method is used to defuzzify the profit function. Then, to test the validity of the model a numerical example is considered and solved. Finally, to study the effect of changes of different parameters on the optimal solution i.e. average profit, order quantity, stock-in period, cycle length and selling price, sensitivity analysis are performed.

Keywords: Graded Mean Integration Representation Method, Inventory, Price Dependent Demand, Shortages, Triangular Fuzzy Number, Weibull Deterioration

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1. INTRODUCTION

Demand is always one of the most influential factors in the decision making relating to inventory policy. In the existing literature of inventory control theory, it is observed that various forms of demand (like constant demand, price dependent demand etc.) have been studied by several researchers. In this connection, one may refer to the works of constant demand (Padmanabhan & Vrat, 1990), price dependent demand (Abad, 1996, 2001), time dependent demand (Sachan, 1984), and time and price dependent demand (Wee, 1995). Inventory model for ameliorating items for price dependent demand rate was proposed by (Mondal et al., 2003) and inventory model with price and time dependent demand was developed by (You, 2005). Covert and Philip (1973) developed an inventory model for deteriorating items with Weibull distribution by using two parameters.

In the most of business communications, the supplier allows a specific credit period to the retailer for payment without penalty in order to stimulate the demand of his products. Before the end of the trade credit period, the retailer can sell all the goods and accumulate revenue and earn interest. A higher rate of interest is charged if the payment is not settled by the end of the trade credit period. Goyal (1985) formulated an EOQ model under some conditions of permissible delay in payment. Hwang and Shinn (1997) determined lot-sizing policy for exponential demand when delay in payment is permissible. Aggarwal and Jaggi (1995) developed an ordering policy for deteriorating items under the condition of permissible delay in payment without shortages after that Jamal et al. (1997) extended their model with the consideration of shortages. Jaggi et al. (2008) determined a retailer’s optimal replenishment decisions with trade credit-linked demand under permissible delay in payments. Soni et al. (2010) summarized the work on permissible delay in payment. Recently, Tripathi and Misra (2010) developed EOQ model credit financing in economic ordering policies of non-deteriorating items with time-dependent demand rate in the presence of trade credit using a discounted cash-flow (DCF) approach.

Over the last few decades, several researchers have applied the fuzzy set theory and techniques to develop and solve the inventory problems. The fuzzy set theory was first introduced by Zadeh (1965) and has now been applied in inventory control systems to model behavior more realistically. Kacprzyk and Staniewski (1982) applied the fuzzy set theory to the inventory problem and considered long term inventory policy-making through fuzzy decision making models. After that, several researchers developed the EOQ inventory problems in the fuzzy sense. For example, Park (1987) examined the economic order quantity model by taking ordering costs and inventory holding costs as trapezoidal fuzzy numbers. The mode and median rules were used to defuzzify the total fuzzy cost. Vujosevic et al. (1996) investigated a fuzzy EOQ model by introducing fuzzy inventory costs and fuzzy order costs and obtained fuzzy total cost was defuzzify by the moments method. Yao and Lee (1996) established fuzzy inventory model with backorder for fuzzy order quantity. Chang et al. (1998) developed economic reorder point for fuzzy backorder quantity. Lee and Yao (1999) discussed the fuzzy EOQ model by taking the order quantity as a triangular fuzzy number and they used the centroid method to defuzzify the total cost. Yao and Chiang (2003) developed inventory model without backorder with fuzzy total cost and fuzzy storing cost defuzzified by centroid and signed distance. Chen and Ouyang (2006) discussed a fuzzy model by defuzzify the inventory carrying charge, interest earned and payable as interval-valued triangular fuzzy number and used signed distance method to defuzzify the model. Mahata and Goswami (2006) developed a fuzzy production-inventory model with permissible delay in payment. They assumed the demand and the production rates as fuzzy numbers and defuzzify the associated cost in
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