Time and Price Dependent Demand with Varying Holding Cost Inventory Model for Deteriorating Items

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ABSTRACT

This paper presents an inventory model considering the demand as a parametric dependent linear function of time and price both. The coefficient of time-parameter and coefficient of price-parameter are examined simultaneously and proved that time is dominating variable over price in terms of earning more profit. It is also proved that deterioration of item in the inventory is one of the most sensitive parameter to look into besides many others. The robustness of the suggested model is examined using variations in the input parameters and ranges are specified on which the model is robust on most of occasions and profit is optimal. Two kinds of doubly-demand function strategies are examined and mutually compared in view of the two different cases. Second strategy found better than first. Holding cost is treated as a variable. Theoretical results are supported by numerical based simulation study with robustness. Some recommendations are given at the end for the inventory managers and also open problems are discussed for researchers. This model is more realistic than considered by earlier author.

Keywords: *Business Management, Cycle Time, Inventory, Order Quantity, Replenishment, Shortage, Time and Price Dependent Demand, Variable Selling Price, Varying Holding Cost*

INTRODUCTION

The inventory of items is an essential need for the businessman and warehouse managers in order to earn more and more profit and to maintain a uniform balance between the demand and supply levels. The nature of items is widely spread characteristic affected by market forces like production, need, requirement, transportation, season etc. Many inventory items are perishable over long duration, and some are over small span of time like milk deteriorates within few days while potato within months. Green vegetables are for few days, and pickles are of few years.

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The price and cost of items stored are also vital forces influencing the demand supply chain mechanism of the market. The holding cost of item in the inventory varies over seasons, size of items, demand pattern and facilities in the equipped warehouses. Inventory problem is also affected by the inflation rate, shortage of items, order size, price fluctuations, discount strategies and marketing plans. The time factor is an in-depth basis having in the inventory decision making process an important role.

Within (1955) was first to integrate the concept of inventory theory to the concept of price theory. He analyzed the simultaneous determination of the price prospect and order quantity decisions of a retailer. Situation when all other assumptions of the EOQ model are valid he took demand as a price sensitive parameter.

Hariga (1996) studied the effect of inflation and time-value of money on the inventory model by time-dependent demand rate with shortage. His contribution is applicable to both growing and declining markets. Federgruen and Heching (1999) had shown the optimum inventory level after ordering when the price changes are strategic substitute. They analyzed price and inventory together in an incapacitated system with the stochastic demand and the time dependent parameters. Khouja (2000) discussed optimal policy with an offer of discount in selling price. Further valuable contents in this stream of the literature are surveyed by Matsuyama (2001) with increasing demand for the deteriorating item.

Joglekar (2003) presented the price optimization and the order quantity strategies for the reseller of a product with price sensitive demand and increasing price strategy at the time of entering into the next cycle. This content proved that a retailer who sets two different prices at the two different points in an inventory cycle gets more profit than a single fixed price throughout the cycle. In similar setup, Mondal *et al.* (2003) examined the effect of price sensitive demand on EOQ model with the constant holding cost for ameliorating items. Abad (2003) derived an optimal pricing policy subject to condition when the supplier offers price reduction in a time interval. Chun (2003) revisited the idea for the optimal pricing when supplier offers to reduce the price for a short duration. Emaghraby and Keskinocak (2003) presented a dynamic pricing policy in presence of inventory for the deteriorating items. The effect on inventory policy by price sensitive demand is acknowledged due to Lee and Joglakar (2005).

You (2005) in a contribution picked up the problem of joint determination of order size and optimal price for the perishable inventory system subject to condition when demand is exponentially decreasing and price is sensitive. It is with the assumption that a decision maker gets an optimal level to adjust price before entering into next time interval to influence demand and revenue both. Wen and Chen (2005) designed a mathematical dynamic pricing model on the Internet market scenario. The EOQ model suggested by Hou and Lin (2006) reflects how the demand is price and time dependent affecting the discount pattern provided in cash. This contribution further proposes an economic order quantity inventory model with inflation and time value of money for the stock dependent selling price.

Sabahno (2009) contributed an inventory model with finite and constant replenishment rate, price dependent demand, time value of money and examined inflation impact with exponential deterioration rate. Some other useful contributions to the EOQ inventory models are due to Srivastava and Gupta (2007); Banerjee and Agrawal (2008); Banerjee and Meitei (2010); Shukla et al. (2010a, 2010b) etc.

Roy (2008) designed a mathematical inventory model considering the deterioration rate proportional to the time, demand (D) as a linear function of price (p), like $D = a - p$ and the holding cost a variable. This model has a transformation parameter β related to the optimal time and the cycle time. He performed analysis using situations with and without shortage of items. Shukla *et al.* (2009) introduced the idea of using three warehouses for storing the deteriorating items with varying holding cost which helps in crucial decision making to inventory managers.