Chapter 7
Dynamic Pricing and Ordering Policies With Quality and Physical Deterioration Under Quadratic Demand

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ABSTRACT

This article includes policies regarding optimal dynamic pricing and ordering for items with synchronized deterioration of quality and physical quantity. Qualitative deterioration is an instantaneous process while physical deterioration—a non-instantaneous process. In view of the dynamic nature of the problem, selling price is assumed to be a time-dependent function of the initial price and discount rate. Initially with no physical deterioration, the product is sold at initial price value in the time period, successively in order to enhance customer’s demand, price is exponentially discounted. For boosting the dynamic essence of the proposed model, the customer’s demand is expressed as a quadratic function of time, price and changes in price over time, which is appropriate for the products for which demand increases initially and after sometime, it starts to decrease. Along with determining initial price, discount rate and optimal ordering cycle, the model also maximizes the total profit of the system. Numerical results with sensitivity analysis on the decision variables outputs managerial insights.

INTRODUCTION

In earlier literatures, unrealistic assumptions were made about infinite life cycle of goods, as such most of the goods by dropping their initial value undergoes deterioration over time by Geetha and Uthayakumar (2010). Deterioration reduces the quality and physical quantity of inventory and so, simultaneously system is burdened by an additional cost. Moreover, in recent research papers much emphasis on dete-
Deterioration is drawn to highlight the shorter life cycles of goods. Therefore, accurate inventory control of deterioration of items is considered to be an important issue to elaborate.

In order to reimburse the effect of deterioration, retailers adopt various marketing policies to uplift inventory depletion rate. Selling price of an item is considered to be a significant factor in upgrading customer’s demand, which is directly influenced by customer’s satisfaction level. Therefore, an organization can gain profit and fulfill customer’s demand by choosing a suitable pricing policy. By adopting a dominant pricing policy, called dynamic pricing policy, a retailer holds the authority to change price over time due to different stock levels, demand levels, quality and other influential factors.

Time-Temperature Indicators (TTI) and Radio Frequency Identification Devices (RFID), are the powerful inventory management tools based on tracking and monitoring technologies Qin, Wang and Wei (2014), by which a retailer can easily judge the qualitative and quantitative attributes of deterioration instantaneously.

Recently, in the area of operation research and revenue management, much emphasis is drawn on work comprising of Joint pricing and inventory control of deteriorating items. Initially, a two period life time product having demand of each period as a random price dependent function was investigated by Jia and Hu (2007). Then the same problem with a bi-level supply chain for a multi-product and multi-period system was considered by Ghasemy Yaghin et al. (2012). The similar situation was handled by Chen and Sapra (2013), in two different inventory setups: First-In-First-Out (FIFO) and Last-In-First-Out (LIFO).

Initially, the concept of non-instantaneous deterioration was introduced by Wu et al. (2006) describing the suitable deterioration pattern of various products. Optimal price and inventory policies with permissible delay in payments for non-instantaneous deteriorating items were studied by Soni and Patel (2012). Then elaborating the earlier model, Soni and Patel (2013) included inaccurate deterioration free time and credibility constraints. An inventory model describing non-instantaneous deteriorating items was proposed by Shah et al. (2013) which consists of demand as a function of selling price and the frequency of advertisement. Further, the concept of non-instantaneous deterioration was highlighted by many other authors like Panda et al. (2013), Zhang et al. (2015), Ghoreishi et al. (2014) and Maihami and Nakhái (2012, 2012).

A model on dynamic pricing was firstly proposed by Cai et al. (2013), where price was considered as a function of time and after considering feedback of price on demand per unit time, the optimal policy was gained. Another study comprising of price as a function of time was considered in which two static pricing models were described, a uniform pricing model and a two-stage pricing model, and shows the importance of dynamic strategy on comparison with dynamic pricing with the two models. In order to demonstrate the dynamic nature of a problem, Rabbani et al. (2015) proposed a model where price is considered as a function of time and demand include effect of price change.

An investigation of applying time-temperature indicators for inventory management of perishable goods were undertaken by Herbon et al. (2014) including the concept of dynamic pricing to attract customers for buying goods reaching the expiry date by considering price to decrease exponentially over time. A model was introduced containing demand dependent on price and quality of items for perishable food inventory system by Liu et al. (2015).

An investigation by Soni (2013), was undergone including optimal replenishment policies for deteriorating items with price and stock sensitive demand under permissible delay in payments. The demand was also including to the inventory level by Lu et al. (2016).

A generalized EOQ (economic order quantity) model for deteriorating items under bi-level trade credit financing was explained by Soni and Joshi (2013). A joint dynamic pricing and inventory control