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Applied Mathematical Modelling

journal homepage: www.elsevier.com/locate/apm

An economic order quantity model for deteriorating item in a purchasing system with multiple prepayments



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ARTICLE INFO

Article history:

Received 27 September 2012

Received in revised form 5 January 2014

Accepted 12 February 2014

Available online 24 February 2014

Keywords:

Inventory control

Purchasing

Shortage

Consecutive Payments

Backordering

Deterioration

ABSTRACT

In the classic economic order quantity model the purchasing cost of an order should be paid at the time of its receipt. Sometimes, retailers ask purchasers to pay all or a fraction of the purchasing cost in advance and sometimes allow them to divide the prepayment into several equal-sized parts. In this paper, economic order quantity model for a deteriorating product with and without shortage under consecutive prepayments are developed. Numerical examples illustrate the proposed models and solution method and sensitivity analysis provides some managerial insights for managers.

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1. Introduction and literature review

Economic order quantity model is one of the famous inventory control systems widely investigated and developed by many researchers. This model has developed under several assumptions some of which are rarely met. The classic EOQ model is used when product is non-perishable and purchasing cost should be paid at the time of delivery.

Timing the payment of purchasing cost has a significant impact on the decision variables of inventory control systems. There are three different strategies for paying the ordering cost including (i) payment at the time of delivery [1] (ii) postponed payment or credit payment [2] and (iii) prepayment [3]. We can expect that the postponed payment or the credit payment is offered by vendors in competitive markets and prepayment strategy can be offered in exclusive markets while payment at the time of delivery is commonly used. On the other hand perishability of products is an important issue which is studied by many researchers because of its main effects on inventory costs and managements. In this paper we focus on the economic order quantity model for deteriorating product when a fraction of purchasing cost should be prepaid. A good example for this problem is a distributor of deteriorating chemical material who wants to determine its order quantity. Its supplier requests the supplier to pay a fraction of the purchasing cost as prepayment with the remaining purchasing cost to be paid at the time of delivery.

Inventory control models for deteriorating items have been widely investigated. The first model for perishable products was developed by Ghare and Schrader [4] in which the deteriorating rate was assumed constant and the purchasing cost should be paid at the time of delivery. Under this payment strategy, Covert and Philip [5] extended Ghare and Schrader's constant deterioration rate to a two-parameter Weibull distribution. This research topic continues to be investigated by

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many researchers. Goyal and Giri [6] and Bakker et al. [7] reviewed inventory control models developed for deteriorating items until and after 2001 respectively.

Credit financing strategies has also been considered with inventory problems. Jaggi and Aggarwal [8] proposed an inventory control model for deteriorating items where shortages are not permitted. Sarkar et al. [9] extended an EOQ model for perishable items under inflation, permissible delay in payment and backordering. Chen [10] developed an EOQ model to consider the effects of the inflation, deterioration, initial stock-dependent demand rates and wholesaler's permissible delay in payment where shortages are not allowed. Chang [11] extended an EOQ model where a retailer considers permissible delay in payments if orders are large. Chang [11] assumed that shortages are not permitted and the effects of the deterioration and inflation rates, and delayed payment policy are discussed.

There are situations where an advanced payment for a purchased order is made. Maiti et al. [12] have studied the effect of advanced payment on profits and inventory decisions. They considered the holding, ordering, purchasing and advertising costs to be constant in their proposed model. Zhang [13] believed that a prepayment scheme is used when a payment larger than the billed amount is made. Zhang [13] presented a model for determining the optimal amount of cash deposit when there is fix prepayment costs. His model balanced the tradeoff between several fixed payment costs with the consideration of lost interest on cash deposits. Recently, Taleizadeh et al. [14] developed a constraint joint replenishment inventory control problem that considers importing raw material from another country where a fraction of the purchasing cost is paid as prepayment. Taleizadeh et al. [3] developed an economic order quantity model with partial backordering and multiple prepayments.

In this paper, an economic order quantity model for a deteriorating product with and without shortage under consecutive partial prepayments is developed. The rest of this paper is organized as follow. In Section 2, the problem with its assumptions is defined and in Section 3, the mathematical models of defined problems are developed and their solution methods are proposed. Numerical examples and sensitivity analysis are performed in Section 4, and finally, the conclusion and recommendations for future research are presented in Section 5.

2. Problem definition

Consider a situation where a supplier asks his customers to prepay a fraction, β , of the purchasing cost when an order is placed, as the first prepayment at time t_1 before the delivery of a lot. The supplier may ask that a prepayment is made to settle the balance or in multiple installments at equal intervals. In a prepayment purchasing system the capital cost of the costumer will increase because he/she has incurred interest costs on β percent of the purchasing cost of products which have not yet been received. Also it is assumed that N , the number of prepayments, offered by the supplier. In the following, two economic order quantity models for a deteriorating item with multiple prepayments are developed. (1) With no backordering and (2) with full backordering. Both models assume that the demand and deteriorating rates to be constants.

3. Model development

The parameters and variables of the models are introduced in Section 3.1 and in Section 3.2 both models are developed.

3.1. Notation

The following notations are used to model the problem.

Parameters

A	the fixed ordering cost
β	the fraction of purchasing cost must be paid as multiple advanced payments
C_p	the purchasing cost of an item
d	the constant demand per period
C_h	the holding cost per unit per period
i_1	the capital cost rate per unit time
θ	the constant deterioration rate
t_1	the length of time during which the buyer will pay the prepayments
N	the number of equally spaced prepayments to be made before receiving the order
C_b	the backorder cost per unit per period

Decision variables

b	the backordered quantity
K	the percentage of demand that will be filled from stock
q	the order quantity
T	the length of an inventory cycle

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