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A Deterministic Economic Order Quantity Model with Delays in Payments and Price Discount Offers

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Abstract
Inventories are being considered to be an important aspect for any organization. EOQ model is defined as a controller of quantity and total cost per unit. The main objective of this paper is to generate model for the profit of profit maximization strategy for retailer when confronted with trade offer of credit and price discount for merchandise. In present situation, retailers have to correlate between the selling price and supplier's price and supplier's trade offer, keeping in mind profit maximization strategy. In the proposed model, all deterministic demands are discussed analytically, numerically and graphically in the environment of permissible delay in payment and discount offer to the retailer with varies time't'. This paper focus on retailer's payment system that they are not ready for full payment as soon as the items received and want such period of time and to fulfill this condition present model is derived.
Keywords: EOQ Model, price discount, delay payment, Replenishment rate, time (t).

I. Introduction

The past EOQ model considers that retailer pays purchasing cost for the items as soon as the items are received while in present market, it is not possible. The supplier offers to retailers a delay period which is known as trade credit period, in payment of purchasing cost. During this period, the retailer can earn revenues by selling items and by earning interests. In a competitive market, the supplier offers different delay periods with different price discounts to encourage the retailer to order more quantities and also offer cash discount to encourage them to make payment in short time (quick payment).

Assumptions: -

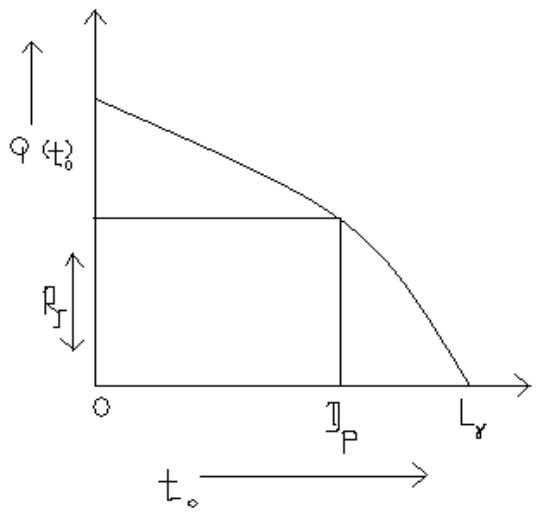
(1) The inventory system (model) involves a single type of items.
(2) No shortages are permitted.
(3) Replenishment is instantaneous (immediately).
(4) Lead time is neglected.
(5) Permissible delay in payment to the supplier by the retailer is considered. The supplier offers different discount rates of price at different delay periods.
(6) Planning horizon is infinite.
(7) Consider time't' is greater than or equal to 1. ($t \geq 1$) for constants (α and β).

Notations:

(1) $r(.)$: Varying demand rate
(2) $Q(t_0)$: on hand inventory (quantity) at time $t_0 \geq 0$
(3) R_s : replenishment lot size of a cycle
(4) C_o : ordering cost per order
(5) C_c : carrying cost or holding cost per unit time, excluding interest charges.
(6) C_p : purchasing cost / unit cost price of the item which depends on the delay period and supplier's offer
(7) p :selling price per unit
(8) D_p : variable permissible delay period
(9) D_{pi} : ith permissible delay period in settling the amount
(10) δr_i :discount rate in percentage of purchasing cost at i^{th} permissible delay period
(11) i_e :rate of interest which can be earned due to credit balance in delay period
(12) i_c : rate of interest charged for financing inventory
(13) L_r^* : optimum length of replenishment cycle
(14) $AP_{1i}(L_r, D_{pi})$: average profit of the system for $L_r \geq D_{pi}$

II. Calculation of EOQ Model

- **When $L_r > D_p$**



Case: when $L_r > D_p$

The cycle starts with initial lot size (Stock size) R_s and ends with zero inventory at time $t_0 = L_r$. Then the governing differential equation of the on hand inventory is:

$$\frac{dQ(t_0)}{dt_0} = -r(.)\,, with\ Q(t_0) = 0 \le t_0 \le L_r$$

So the total profit has been derived from the following formula.

$$TP_{1i} = \left(D_p - t_0\right)R_s + i_e p \int_0^{D_p} (D_p - t_o)\, r(.)dt_o$$

$$-C_h \int_o^{L_r} Q(t_0)dt_0 - i_c.C_p \int_{D_p}^{L_r} Q(t_0)dt_0$$

$$-C_0,\ for \forall\ D_p \in \{D_{p1}, D_{p2}, D_{p3}\}$$

The average profits are:

$$AP_{1i} = \frac{TP_{1i}}{L_r}\ \ for\ i \in \{1,2,3\}$$

By using lemma 9 an optimum replenishment length is derived as follows:

$$\therefore L^*_r = \sqrt{\frac{(i_c C_p(\delta_i) - i_e p) D D^2_{pi} + 2C_o)}{D(C_c + i_c C_p(\delta_i))}}$$

III. Conclusion

This model gives an optimum profit and average profit for producer. In this model delay in payment and cash discount is considered as important aspects because it attracts the consumers to purchase more and more and also producer can get profit more and more. From the model of replenishment EOQ, one can find optimum EOQ for variable time.

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