



# Inventory policy for an item with inflation induced purchasing price, selling price and demand with immediate part payment

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## ABSTRACT

In this paper, an inventory policy for an item is presented with inflation and selling price dependent demand under deterministic and random planning horizons allowing and not allowing shortages. In addition, there is a provision for (i) an immediate part payment (variable) to the wholesaler, (ii) borrowing some money from money lending source for the immediate part payment, (iii) earning a discount on purchasing price and relaxation on credit period from the wholesaler against the advance payment and (iv) delay in payment for the rest allowed by wholesaler. The payment to the source is made at the end of the business period with some interest charged. Against the above conjectures, inventory models under the finite (crisp) and random planning horizons have been formulated with respect to the retailer's point of view for maximum profit. The nonlinear optimization method – Generalized Reduced Gradient (GRG) method is used to find the optimal solutions and the corresponding maximum profits for the different sets of given numerical data. Some sensitivity analyses are made and presented graphically. As particular cases, the results of the crisp models and the case without shortages are obtained from those of the stochastic model and the case with shortages respectively.

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## 1. Introduction

Normally, the payment for an order is made by the retailer to the supplier immediately just after the receipt of the consignment. Now-a-days, due to the stiff competition in the market, to attract more customers, a credit period is offered by the supplier to the retailer. Moreover, for the speedy movement of capital, a wholesaler tries to maximize his/her market through several means. For this, very often some concessions in terms of unit price, credit period, etc., are offered to the retailers against immediate full/part payment. To avail these benefits, a retailer is tempted to cash down a part of the payment immediately even making a loan from the money lending source which charges interest against this loan. Now the retailer is in dilemma for optimal procurement and also for the amount for immediate part payment. Here an amount, borrowed from the money lending source as a loan with interest, is paid to the wholesaler at the beginning on receipt of goods. In return, the wholesaler/supplier offers a relaxed credit period as permissible delay in payment of rest amount and a reduced unit purchasing price depending on the amount of immediate part payment.

Inflation also plays an important role for the optimal order policy and influences the demand of certain products. As inflation increases, the value of money goes down and erodes the future worth of saving and forces one for more current

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spending. Usually, these spending are on peripherals and luxury items that give rise to demand of these items. As a result, the effect of inflation and time value of the money cannot be ignored for determining the optimal inventory policy.

In the present paper, an inventory control system in which immediate part payment and the delay-payment for the rest are allowed by the wholesaler for an item over a finite planning horizon or random planning horizon with selling price and inflation induced demand is considered. In addition, against an immediate part payment (variable) to the wholesaler, there is a provision for (i) borrowing money from a money lending source and (ii) earning a discount on purchasing price and relaxation on credit period from the wholesaler. The models are developed with respect to the retailer for maximum profit. The randomness in the planning horizon has been removed using the chance-constraint technique. Single objective problems incorporating immediate part payment, delay in payment for the rest, and selling price, inflation dependent demand are formulated to maximize the profit function with/without shortages and solved using Generalized Reduced Gradient (GRG) method. The decision variables for these inventory models are the immediate part payment and number of cycles. These models are illustrated with numerical examples. Finally, the sensitivity analyses for the profit function and immediate part payment with respect to some parameters are carried out and the results are presented graphically.

## 2. Literature review

First, Goyal [1] presented an EOQ model under the conditions of permissible delay in payments. Since then, lots of literature is available in this area of study. The interesting papers related to such studies are Chu et al. [2], Chung [3], Jamal et al. [4], Sarker et al. [5] and others. Shah [6] considered the time value of money along with the trade credit for a finite time horizon inventory model with deteriorating items. Effect of inflation and time value of money is also well established in inventory problems. Initially, Buzacott [7] used the inflation subject to different types of pricing policies. Then consequently in the subsequent years, Moon and Lee [8], Chen [9], Dey et al. [10], Padmanavan and Vrat [11], Hariga and Ben-daya [12], and others worked in this area. Jaggi et al. [13] developed an inventory model with shortages, in which units are deteriorating at constant rate and demand rate is increasing exponentially due to inflation over a finite planning horizon using discount cash flow approach. Most recently, Chen and Kang [14] and Huang [15] presented integrated inventory models considering permissible delay in payment and variant pricing strategy for determining the optimal replenishment time interval and replenishment frequency. Tripathi et al. [16] developed a cash flow oriented EOQ model under permissible delay in payments for non-deteriorating items and time-dependent demand rate under inflation and time discounting. Liao et al. [17], Chung and Liao [18] dealt with the problem of determining the EOQ for exponentially deteriorating items under permissible delay in payment depending on the ordered quantity and developed an efficient solution-finding procedure to determine the retailer's optimal ordering policy. Chang [19] extended Chung and Liao's model by taking into account the inflation and finite time horizon with large quantity of purchase orders. Yang [20] presented an inventory model with different pricing policies. Singh et al. [21] proposed a two warehouse model under inflation with large quantity of purchase orders. Chung and Huang [22] studied ordering policy with permissible delay in payments to show the convexity of total annual variable cost function. Barron et al. [23] demonstrated optimal order size to take advantage of a one-time discount offer with allowable backorders when the supplier offers a temporary fixed percentage discount and has specified a minimum quantity of additional units to purchase. Recently, Guria et al. [24] proposed a pricing model for petrol/diesel and determined the optimal ordering policy for an existing petrol/diesel retailing station under permissible delay in payment with and without fully backlogged shortages. Several authors like Panda and Maiti [25] investigated the inventory models of this type of item. Joint price and lot size determination problems for deteriorating products were studied by Kim et al. [26]. Abad [27] investigated the inventory models of this type of item. Jaggi et al. [28,29], Liang and Zhou [30] solved two warehouse inventory models for deteriorating items with price dependent demand. Dey et al. [31] developed a two-storage inventory model with shortages and lead time in which units are non-deteriorating and demand is dynamic under inflation and time-value-money. It is a fact that the demand of an item is influenced by the selling price of that item i.e. whenever the selling price of an item increases, the demand of that decreases and vice-versa. Maiti et al. [32] introduced the concept of advanced payment for determining the optimal ordering policy under stochastic lead-time and price dependent demand condition.

Though several articles are available in the area of the inventory models with permissible delay in payment, there are some lacunas in the above mentioned literature. These are:

- Though the part payment at the time of purchase is now-a-days a part of the business from both ends – i.e., to bring immediate cash to the wholesaler and to give some price and payment concessions to the retailer, this has been ignored by the researchers.
- Most of the above inventory models are developed for infinite planning horizon with the common assumptions that lifetime of the product is infinite. Due to fluctuating world economy, cost of raw materials as well as production cost of a product changes rapidly. Also, with time, fashion and liking of the customers change and the introduction of multinationals leads to change in product specifications with new features. So, in reality lifetime of a product is finite and uncertain. Very few articles (cf. [33–36] etc.) are there incorporating this assumption.

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