CHAPTER I

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Inventory management of physical goods is an integral part of logistic system common to all sectors of the economy such as business, inventory, agriculture, defense etc. In these systems, inventories are maintained to regulate the production process and / or to protect against risk of stock outs.

Inventory is a physical stock of goods kept for the purpose of future utilization. An inventory of material becomes essential in order

i) to promote smooth and efficient running of business,

ii) to provide an adequate service to the customer,

iii) to take advantage of price discount to bulk purchasing,

iv) to delay the payments of the orders,

v) to purchase units in bulk before price increase becomes effective or during the specified discounted period,

vi) to provide a safeguard for variations in raw material delivery time or lead time to allow flexibility in production scheduling etc..

1.1 LITERATURE SURVEY:

The first mathematical model referred to as "WILSON'S LOT SIZE MODEL" or "ECONOMIC ORDER QUANTITY MODEL" was developed by HARRIS and WILSON in 1915. The problem was to minimize the total cost per time unit ( or total expected cost per time unit in case of uncertainty in demand ) or to maximize the total gain per time unit ( or total expected gain per time unit in case of uncertainty
in demand). Some of the stagnant assumptions made in the classical ECONOMIC ORDER QUANTITY (EOQ) model are as follows:

i) The demand rate of R units per time unit is known and constant.

ii) Lead time is zero.

iii) The cost of the units remain constant throughout the period under review.

iv) The payments of the goods received by the system is made as soon as the goods are received by the system.

v) There is no damage or deterioration of the goods while in inventory.

vi) The quantity received matches exactly with the quantity ordered or requisitioned.

etc.

A number of research papers have appeared analyzing mathematical models of inventory control under various costs and demand structures and restrictive situations and/or conditions. These models are broadly classified under two categories: Deterministic and Probabilistic models. A description and analysis of these models are given in standard text books on inventory control viz. Naddor [13], Tersine [21], Wagner [22] etc.

However, in practice, we frequently come across the systems where assumptions of classical inventory model are violated. Thus, there is an increasing need for deriving inventory models in which one or more of these assumptions are relaxed.

In general, we find that the quantity received does not match with the quantity requisitioned. Silver [19] has developed an inventory model when the amount received is uncertain under the
assumption that lot does not contain any defective item. E. Sankara, Subramanian and S. Kumarswamy [4] considered a single period problem with random demand, fixed cost per unit and used the criteria of maximizing the probability of achieving a desired level of profit under the assumption that lot does not contain any defective item.

Goyal [6] considered an EOQ model when delay in payments of order is permitted. However, he assumed that shortages are not allowed. Shah, Patel and Shah [18] developed an EOQ model under similar situation by allowing shortages. Davis and Gaither [3] have developed an inventory model under conditions of extended payment privileges. However, they assumed that lot does not contain any defective item. Mandal and Phaujdar [12] also developed some EOQ models under permissible delay in payments when items in inventory are not subject to deterioration.


In this thesis, some of the work done by the of above authors have been extended by relaxing some or the other assumptions of the model. In particular, an attempt is made to develop stochastic
models when units in inventory are subjected to deterioration and under above mentioned constraints.

1.2 OUTLINE OF THE STUDY:

In the conventional EOQ model, it is specifically assumed that the quantity received matches with the quantity requisitioned and there is no damage or deterioration of the units in inventory. In practice, due to variety of reasons viz. machine's breakdown, worker's strike, electricity failure, shortage of raw materials, etc. it is found that quantity received does not necessarily match with quantity ordered but may be a random variable depending on the quantity ordered. Silver [19] has developed an EOQ model when the quantity received is uncertain. Kalro and Gohil [10] have extended this result to allow shortages. Ghare and Schrader [5] have developed an EOQ model for exponentially deteriorating inventory which has been generalized by Covert and Philip [1] and Philip [15] by using the Weibull distribution to describe time to deterioration of an item in inventory.

In chapter II, we have analyzed an EOQ model for deteriorating items when supply is random, production rate is infinite and shortages are not allowed under an assumption that random variable is normally distributed. The same model has been extended for finite production rate.

In deterministic inventory models, it was tacitly assumed that the demand rate per unit of time is known and constant. In practice, the demands for units stocked by an inventory system can seldom be predicted with certainty. In such cases, demands for units can be described in probabilistic terms, that is, one can
assume a probability distribution for the demands. It was assumed that this probability distribution is stationary over time.

An inventory model in which the price of the units being replenished is expected to increase by fixed amount is considered by Naddor [13], Lev & Weiss [11], Goyal & Bhatt [8]. Taylor and Bradley [20] first determined an integral number of purchase orders of equal size during the interval at which the stock held reaches zero level and the time at which the increase in price becomes effective and then place a special order just at which the increase in price becomes effective. They defined such a policy as the MODIFIED LOT SIZE STRATEGY ( MLS - strategy ). The situation in which no replenishment order is scheduled, before the time at which the increase in price is to be effective, however, there must be remnant stock at specified time after which price increases, is considered by Torsiome [21]. In such a situation, it is logical that a large quantity should be procured just before the price increase becomes effective. The purchase of too large quantity will considerably increase the carrying cost. If we do not purchase large quantity at present lower price then the unit cost will increase. Therefore, problem reduces so as to decide the optimum amount which should be procured just before the price increase becomes effective.

Secondly, whenever a supplier gives an advance notice to the buyer of the discount in the unit purchase price for a product, the buyer would like to take advantage of the opportunities of buying the product at a lower unit price during the specified period. The decision problem facing the buyer is to determine the
economic ordering policy during the time interval, the units can be procured at lower unit price. If we do not purchase large quantity at the present lower price then the unit's cost will increase.

In both cases, one time decision is to be made. In chapter III, we try to determine optimum cycle time by comparing cost of not taking advantage of known price increase (discount) with the cost of purchasing large quantity just before (after) the price changes, which maximizes the gain.

The above mentioned problem becomes more complex when the items in stock are subjected to deterioration while in inventory, so that the large purchases may result in loss due to more deterioration. In such case, we have to balance the cost due to increase (or discount) in unit price against the increase in cost due to deterioration. The optimum cycle time is derived which maximizes the gain due to difference of the two costs which has been discussed in chapter IV.

In CHAPTER V, stochastic and deterministic models without and with exponentially deteriorating inventory, when delay in payments is permissible, are studied. The models studied here are extensions of Goyal [6], Shah, Patel and Shah [18] and Mandal and Phaujdar [12], where they have developed EOQ models without shortages, with shortages, by including interest earned from the sales revenue on the stock remaining beyond the settlement period respectively.

In CHAPTER VI, we discuss the probabilistic order level system when delay in payments is permissible. In second part of
the chapter, an attempt is made to study the same model when units in inventory are subjected to deterioration.

CHAPTER VII contains probabilistic order level system with lead time when supplier allows some credit period for settling the account.

In CHAPTERS V, VI, VII, the models are analyzed under two different possibilities:

i) The period of permissible delay is less than or equal to the reordering time, and

ii) The time of permissible delay is greater than the reordering period.

Part of the work contained in this thesis has been presented, published / accepted for publication in proceedings of conferences and / or journals. A list of papers prepared out of this thesis is included at the end of conclusion chapter.