CHAPTER-2
REVIEW OF LITERATURE

Literature Review

This chapter provides a survey of the literature dealing with inventory problems and other concepts considered in this thesis. The purpose of this chapter is to review the developments and to identify the status of existing literature in this area. The aim of this chapter is to present a complete and update picture of inventory theory related to the problem. The review of the related literature is an essential aspect of the research work.

There are many areas of inventory models. Those researches areas have been discovered in several ways in order to make the model closed to the real world practice. These aspects give rise to many alternatives of the inventory models.

2.1 Survey of Inventory Models with Deterioration

In modern time, precise and methodical ideas have been used in diverse area in existent problems, predominantly for controlling stock. One of the essential concern of the administration is to come to a decision that at what time and how a large amount to arrange, order, assemble or to produce so that the whole cost coupled with the inventory scheme
should be bare minimum. This is to some extent more significant, when the inventories undergo rot, decay, fester or wear and tear with deterioration. The majority of the researchers in inventory system were intended for non-deteriorating goods. Nevertheless, there are certain substance, whose usefulness and value do not continue to remain similar with the course of time. Deterioration and worsening of these objects and items plays an essential function and items cannot be stored for a elongated time. Deterioration of an item means disintegration, decomposition, putrefaction, antiquated, out of date, loss of effectiveness, loss of value and needs substitution of an inventory from the elementary form. When the substance of the article of trade are kept in store as an inventory for satisfying the potential and upcoming demand, there may be the wear and tear of items in the inventory scheme, which may take place owing to one or various factors i.e. storage space environment, climate conditions and surroundings or due to dampness.

The problems of inventory for the deteriorating goods have been studied with much interest by most researchers from a long period of time. Whitin (1957) started his research in this field and considered fashion industry goods deteriorating.
**Ghare** and **Schrader (1963)** began studying inventory problems having deterioration of items. An inventory system with exponential decaying function in inventory was first developed by them. Generally with time certain products shrink and is approximated as negative exponentially.

**Covert** and **Philip (1973)** presented an economic order quantity representation for substance which pursue the two parameter Weibull distribution.

**Shah and Jaiswal (1977)** presented an order level inventory model with a constant rate of deterioration.

**Dave and Patel (1981)** were the pioneers to formulate inventory model for decaying items and having time dependent demand.

Along with this they considered time varying demand where shortages were not allowed.

**Roychowdhury and Chaudhuri (1983)** formulated an order point stock form for worsening items with predetermined rate of replacement.

**Hollier and Mak (1983)** gave inventory replenishment system for deteriorating item with demand rate.
Sachan (1984) also extended this model and allowed shortages of items to occur in the system.

Goyal (1986) suggested inventory models with demand which is not constant.

Dave (1986) also formulated an order level inventory model for deteriorating items. It allows discrete opportunities for replenishment. In this model, demand kept on changing from time unit to time unit and occurs instantaneously at the beginning of each time unit. Deterioration rate was assumed to be constant and lead-time was zero.

Datta and Pal (1988) considered deterministic demand as well as probabilistic demand.

Bahari-Kashani (1989) followed variable period of replenishment in the inventory system.

Dutta and Pal (1990) gave their views on inventory system having demand rate depending on the level of stock available.

Further an model for decay and deteriorating items having demand rate depending on stock was considered by Pal.

Chang & Dye (1999) presented a model for deteriorating substance and products with limited backlogging in determining the economic order quantity. They moreover assumed that the demand rate
was a time varying function. Actually, in some inventory situation, the backlogging rate should be reliant on the duration of the waiting time for the next replacement.

**Wee and Law (2001)** presented an modeling for deterioration in inventory. He has considered time value of money system with price varying demand rate. The model is deterministic in nature One seller and many buyers policy for production and inventory system was given by Tang (2002) Demand rates were taken invariable. A scientific representation including cost of vendor & cost of buyer was considered.

**Ouyang et al. (2006)** formulated a inventory model for non-instantaneous deteriorating items with allowable holdup in payments.

**Musa and Sani (2012)** developed an Inventory ordering policies of delayed deteriorating items under permissible delay in payments.

**Sarkar (2012)** developed an EOQ model for fixed replacement rate where demand rate and deterioration rate are time dependent with postponement in payments.

**Gupta and Singh(2013)** developed an inventory model considering Weibull deterioration. The model uses variable holding cost.

**Tayal et al. (2014)** discussed a two echelon supply chain model for deteriorating items with preservation technology.
2.2 Survey of Inventory Model with Warehouse

At this instant, owing to globalization of economies and with the introduction of global companies in the business, there is a inclination among the business firms, in particular the small to middle size retailers and small retailers of diverse international business products to participate with each other for trade and as an consequence, an essential problem come up in inventory management to decide where to store the goods. In addition, in some realistic situation, when the suppliers offer value discounts for mass purchases or when the goods under thought is a cyclic or irregular product such as the yield of produce or the replacement price is higher than the other associated cost, etc., the inventory manager may buy or acquire more goods than can be stored and piled up in its own warehouse (OW). From cost-effective point of view, they by and large prefer to rent out other warehouses than reconstruct a fresh storehouse. Consequently, the surplus quantity are stored in a rented warehouse (RW). The inventory costs which normally include holding cost and also the deterioration cost in RW are typically higher than those in OW due to extra and added cost of upholding, continuation and material handling.
Hartely (1976) had a great vision to focus on the problem of two warehouses.

Sarma (1983) extended Hartely theory and taking into consideration formulated vast production rate and two levels of storage.

Murdeshwar and Sathi (1985) and Dave (1988) further developed these models.

Sharma (1987) developed an inventory model which considers deterioration of products. Also the products are stored at two warehouses differently. The unit carrying cost of the rented one is more than the owner's warehouses. Eventually the conditions of storage at RW are better than of OW, hence RW offers a lower deterioration rate.

Goswami and Chaudhuri (1992) promoted further a representation with and devoid of shortages by presumptuous of a linear time dependent demand and considered the transportation cost from carrying goods from one warehouse to another depending upon the magnitude being taken through transportation.

Sarma and Naidu (1995) deal with a condition when the capacity and amount of goods received is tentative and usually less than what was planned. Nevertheless, that prospect was assumed when the quantity
received may not fluctuate much from that which has been formerly been prepared, leading to a predicament of physical storage space, causing the buyer to hire a subsequent storehouse.

**Bhunia and Maiti (1994)** corrected the shortcomings of the proposed model and carefully incorporated the parameter of deterioration in the stock.

**Bhunia and Maiti (1998)** in the same year, considered a deterministic EOQ model with different level of deterioration in the two warehouses concerned. The stock was supposed to be moved physically from rented or hired storehouse to the storehouse of the owner. In this there is a pattern of continuous release. The transportation cost is also considered.

**Kar et al (2001)** formulated a inventory model for two warehouses. It considers economic order quantity cost for replenishment and time dependent demand which is linear in nature. The time period is finite in this model.

**Yang (2004)** considered an inventory modeling for two warehouse in which the demand reaming constant. Shortages can be allowed. The entire environment is considered to be inflation oriented. In this model the old classical approach is not taken into account but an alternative
approach is shown. Actually every production phase will commence with shortages. This model will definitely be more economical in operation.

**Zhou** and **Yang (2005)** developed a model in which no shortages are there. The demand is dependent on the stock variable. The transportation cost will be based on the quantity. The deterioration of items are not considered.

**Yang (2006)** extended to have as a feature of partial backlogging and then compare with the other two-warehouse models having lowest cost approach. He showed that the enhanced model was actually economical to function. The model should consider effect of inflation and backlogging of items should be partial and not absolute.

**Maiti et al. (2006)** took to study this problem with time value of money by taking two rented warehouses, one (RW<sub>1</sub>) at central location whereas the other (RW<sub>2</sub>) can be at near distant location. The inventories are stored at both the warehouses, although they are sold from RW<sub>1</sub>. A number of studies have been done considering the importance of warehousing along with inflation.
Dey et al. (2008) have recently taken a two warehouse system with inflationary implications. Due to diverse preserving conveniences and storage space surroundings, stock holding cost is measured to be dissimilar in different storehouses. The shortages may or may not be permitted in the last phase and, there may be three dissimilar kinds of model. At this point it is understood that the replacement cycle length are of equal length. The stock of rented storehouse is transferred to owner storehouse. In support of the model, special scenarios are depicting depending on the re-order point for the subsequent batch.

Lee and Hsu (2009) explained a two-warehouse model for failing items with time varying demand. They adopted cycle times to calculate the number of manufacturing cycles. It also calculate the replenishment cycle. The planning period is taken as finite.

Singh et al (2011) discussed the two warehouse model with allowable postponement in disbursement in fuzzy situation.

Liao et al. (2012) determined economic order quantity for deteriorating substance with two level storage space facilities. One is own warehouse and the additional one is a borrowed and hired warehouse. The trade credit is linked to order quantity.
Yang (2012) developed the two-warehouse fractional backlogging inventory model to integrate three-parameter Weibull deterioration distribution and derive the policy which should be optimally suited for replenishment. This model should reduce the entire cost per unit time.

Singh and Vishnoi (2013) discussed a supply chain model with price varying utilization rate with ameliorating and deteriorating items and two levels of storage.

Kumar and Singh (2014) presented a two storehouse inventory model for deteriorating items with demand rate depending on stock and backlogging is partial.

2.3 Survey of Inventory Model with Inflation

Actually in the traditional inventory models, the various costs associated with the inventories are considered constant over a period of time. This does not depict a realistic view of the situation. Mostly these models are developed without the inclusion of parameters of inflation, deterioration and time value of money. Due to international economic situations and ever changing prices due to inflation in almost all the countries of the world during the last twenty years have changed extensively. These days inflation play an important role in inventory
management system. Inflation has greater effect on net present value of futuristic inventory costing.

**Buzacott (1975)** has done a pioneering job for developing an EOQ model which considers inflation as a parameter. The inflation is taken as uniform in nature. All the costs associated with inventory have effect due to inflation in the market. So the average cost annually should be minimized in order to earn maximum profit.

**Bose (1995)** discussed an inventory model for decaying products and within the model for lot size, the demand was taken to be linear but it allowed shortages of inventory. The backlogging was allowed in the model. Due to inclusion of parameters of inflation the model was quite useful. It also included the parameters of time worth of money. The deterioration of substance at the homogeneous rate is also considered in this model.

**Liao et al. (2000)** formulated an inventory modeling for the consumption rate which is stock dependent. The trade credit policy is allowed and there can be delay in certain payments encouraging the vendors to buy the products and the benefits are transferred to them.

**Wee and Law (2001)** discussed a system having deterministic view about inventory system. Time value of money is taken into account.
The demand definitely depends upon the price of the products. In this model profit maximization approach is followed.

DCF approach is used for the analysis of problems. The pricing policy and replenishment policy uses heuristic approach in order to maximize the profits.

**Moon et al. (2005)** formulating models for inventory using ameliorating items. It has finite time period. The demand is taken to be time varying. Effects of inflation is also accounted for.

**Dey (2008)** considered a model with problem of decaying items. Time value of money & inflationary environment are also considered. Two warehouse that is one is own storehouse and the additional one is a borrowed storehouse is considered.

**Yang et al. (2010)** discussed a model for lot size for deterioration items which is studied under inflation. The demand is usually stock dependent. The shortages are generally partially backlogged. The replenishment cycles are time dependent.

**Sarkar and Moon** (2011) considered a production model for stochastic demand having effect of the inflation in the system.

**Neetu and Tomer** (2012) studied a deteriorating inventory model under variable rate of inflation.
2.4 Literature Survey of Inventory Models with Lost Sale:

An important issue in the supply chain models is related to how to deal with the unfulfilled demands which occur during shortages or stock outs. In the majority of the models research scientist understood that the shortages has to be absolutely backlogged or totally lost. The initial case where the unfulfilled demand is completely back ordered is also known as backordered or backlogging case. In the later case, also known as lost sale case, it is assumed that the unfulfilled demand is completely lost. But in realistic market oriented situation, neither all the consumers wait for the next replacement nor is unfulfilled demand completely lost. There happen the situations when some of the consumers normally wait for the subsequent replacement and remaining not. Therefore, the concept of partial backlogging should not be ignored.

In most of the traditional inventory models such as Mortan (1971), Nahmias (1982), was often assumed that during the stock-out period, shortages are either completely backordered or completely lost.

Rosenberg (1979) analyzed a model for the lot size with partial backlogging. Some researchers implicitly feel that order throughout the shortage period was to some extent confined i.e., a fraction of the demand will be lost while remaining fraction was backlogged (Wee, 1993).
Pakkala and Achary (1994) formulated an inventory model for decaying products with bulk release rule when two separate warehouses were used. In their model demand was assumed as uniform with fixed replenishment rate, moreover shortages were allowed.

Sarker et al. (2000) developed a system to find out an most favorable ordering policy for invariable demand in inflationary environment. Allowable delay in payment can be there. Furthermore the system will have shortages. The current value of overall cost incurred in this system was measured and then best possible order size and highest permissible shortage were obtained by using a exploration method.

Chung and Lin (2001) developed inventory model followed the DCF to investigate replenishment policy for deteriorating goods with demand which is static and also considering time worth of money over a preset forecast period. They obtained optimal solutions with complete backlogging and without backlogging. The total variable cost was minimized.

Hou (2006) derived a model for decaying items with stock varying consumption rate. Moreover shortages are considered under inflation. Time discounting is over a finite planning horizon.
Dye et al. (2007) had considered an infinite time horizon and developed inventory model for single product where demand rate & deterioration rate were uninterrupted and differentiable function of price and time respectively. In addition they had considered that shortages were completely backlogged.

Jaggi and Verma (2008) presented a two-warehouse model where the demand was price-sensitive under the bulk release rule. Stock-outs were allowed and fully backlogged. Moreover, the cost for transportation was measured on the transported units. The model jointly optimized the selling price and the order quantity by maximizing the system profit.

Yang et al. (2008) developed a shared seller buyer stock system with exponentially diminishing marketplace, limited scope and stable replacement period. They assumed that shortages were permissible and totally backordered.

Singh and Jain (2009) formulated a deterministic model for inventory control by incorporating some realistic features like deterioration, backordering, inflation, time value of money, and supplier credits.
Hsieh et al. (2010) developed EOQ model with power form stockpile dependent demand rate followed by a constant demand rate, permitting shortages and time proportional backlogging rate.

Bijvank and Vis (2011) classified various models which are based on the distinctiveness of the inventory structure and viewed the anticipated replacement policies. For each classification and type of replenishment policy they discussed the available models and their performance.

Lee and Dye (2012) came out with a worsening supply model with stock dependent demand by allowing conservation and protection expertise cost as an assessment variable in combination with substitution policy where shortages are acceptable and to some extent backlogged, depending on the time-span of the waiting time for the subsequent replacement.

Singhal and Singh (2013) developed a multiple items supply system for time varying decaying objects with inexact environment. In some measure backlogged shortages can be there.
REFERENCES


