CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Though the inventories are essential and provide an alternative to production/purchase in future, it also locks up capital of the enterprise. Therefore excess inventories are undesirable. Also lack of inventories harms the business. This calls for controlling the inventories in the most profitable way.

2.2 GENERAL REVIEW

There are many inventory models for single item and multiple products like deterministic models with static or dynamic demand, probabilistic models with stationary or non-stationary demand and fuzzy models as in Figure 1a. A large number of inventory models, developed by many researchers like An et al., Backer and Urban, Das, Donaldson, Fotopoulos, Gerchak and Parlar, Gerchak and Wang, Giri et al., Lee et al., Yu et al., etc. [2, 4, 21, 24, 27, 30, 33, 60, 127], in which the solutions are found by using different strategies. Many authors like Backer and Urban, Chung-Yuan Dye, Giri and Choudhuri, Hwang and Shin, Ou Tang and Robert Grubbstr Om [4, 17, 32, 45, 77] presented deterministic inventory models. Hariga and Ben-Daya, Shah and Shah, Urban [41, 99, 113, 114] considered stochastic inventory models. Many authors like Gerchak and Wang, Urban [31, 113, 114] investigated periodic review inventory models. Ou Tang and Robert Grubbstr Om, Ouyang and Chuang, etc. [77, 78] suggested continuous review inventory models. Banerjee and Banerjee, Chang et al., Goyal and

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According to the demand rate, deterministic inventory models may differ. In practice, most firms have variable demand. The demand series is usually represented as a seasonal demand variation in some companies, especially in high-tech industries. Researchers like Chang and Dye, Donaldson, Jayanta Kumar Dey et al., Silver and Meal [12, 24, 51, 102] studied inventory models with time dependent demand.

We often see mass display of items in stores that are used to attract the customers and to increase the sales. Levin et al., [61], too, recommended this concept of displaying mass items to attract the customers. The operations management literature has recognized this motivating effect of inventory on demand. Models based on this idea have been developed [4, 22, 32, 39, 61, 67, 68, 91, 98, 101, 112, 120]. Researchers like Borin et al., Corstjens and Doyle etc. [9, 20, 23, 112, 123, 128] proposed shelf space allocation models to exploit this relationship.

Erkip et al., Lau and Wang, Lee et al., Urban [25, 58, 60, 113] suggested that the demand for certain commodities were auto-correlated. Kendall and Ord [55] discussed the forecast demand. An autoregressive moving average demand process is considered in the literature [2, 7, 13, 27, 38, 46, 53, 60, 92, 93, 114]. Gerehak and Wang, Stanishlaw, Urban, Wang
and Gerchak [31, 106, 114, 116] presented periodic-review inventory models with several demand patterns.

Veinott [115] showed the optimality of the order-up-to policy for independent demand processes and stated conditions under which a short period policy would be optimal. Subramanyam and Kumaraswamy [107] discussed marketing policies. Production inventory systems are proposed in the literature [94, 103]. Pricing policies for demand are also described in existing literature [3, 14, 71, 72, 95, 124, 126].

Controlling and maintaining the inventories of deteriorating items are important. Deterioration means spoilage, damage, dryness, vaporization etc. There are many products in the real world that are subject to significant rate of deterioration. Hence the impact of product deterioration should not be neglected in the decision process. Some authors like Aggarwal and Jaggi, Chang and Dye, Chen and Chen etc.[1, 12, 14, 17, 18, 44, 45, 48, 63, 67, 68, 98, 117, 118, 122, 127] proposed inventory models for deteriorating items. Jayanta Kumar Dey et al., [50] considered differential items.

The traditional inventory models assume that the retailer’s capital is unrestricted and the supplier must be paid for the items as soon as the items were received. However, this may not be true. In practice, the supplier may offer the retailer a delay period or credit period for settling the accounts. There are several interesting and relevant papers related to the delay of payments [1, 15, 17, 18, 36, 45, 48, 52, 63, 97, 99, 100]. Many researchers like Karlo and Gohil, Kim and Park [54, 56] assumed that the shortages were either completely backlogged or completely lost. Others like Chaung et al., Chang and Dye etc. [10, 12, 17, 82, 83, 85, 117, 122] assumed that demand during stock out period was partially met.
Some inventory models, in which the backlogging rate depends on the length of the waiting time for the next replenishment, are described in [12, 17, 56 and 59]. Backlogging rate may depend on the quantity discount or backorder price discount offered by the supplier. Several researchers like Chaung et al., Das, Jason and Hsiao, Nadjib et al., Porteus [10, 21, 49, 73, 89] developed such interesting models. Authors like Jacker and Rosenblatt, Monahan, Papachristos and Skouri and Peng-Sheng [47, 69, 86, 88] developed inventory models with quantity discounts. Ouyang et al., [82] suggested that backlogging rate could also depend on the length of the lead time through the amount of shortages.

Time and cost are the most important competitive factors in business. A firm has to reduce the lead time to satisfy customer’s demands. The concept of Just-in-time delivery has grown popular in the last two decades. Lead time can be controlled by an extra cost. The extra costs paid to shorten lead time usually consist of administrative costs and supplier speed up costs. Lead time is a topic of interest in the models by Ben-Daya and Raouf, Chung and Huang etc. [6, 16, 21, 26, 41, 49, 51, 58, 65, 70, 72, 74, 79, 80, 81, 82, 84, 96, 106, 108, 110, 112].

Lead time demand plays a vital role in any business. Liao and Shyu, Cheng et al., [62, 111] assumed that lead time demand follows normal distribution. Some researchers like Gallego and Moon [28] assumed that lead time demand’s probability distribution was unknown. They used min-max distribution free procedures to optimize expected total inventory cost [10, 28, 78].
It has been observed in many manufacturing units setup cost can be reduced by investing additional capital. The benefits of reduced setups are well documented by many researchers. Billington, Coates, Hall, Herbert, Hong and others [8, 19, 40, 42, 43, 57, 84, 89, 90, 96, 110] investigated the impact of capital investment in reducing setup costs.

A problem in inventory is the yield of items, by production or procurement. A producer has a chance to choose production process and machines. Modern production technology can improve the production process and amount of yield. Many authors like Gerchak, Gerchak and Parlar, Giri et al., Karlo and Gohil, Lin and Hou etc developed random yield inventory models [29, 30, 33, 54, 64, 66, 75, 76, 87, 104, 105, 116, 125].

In recent times many countries have been confronted with fluctuating effects of inflation. This effect had been considered since 1975. Several researchers like Chang, Liao et al., Ray and Choudhuri, Sarkar et al, [18, 63, 91, 97] discussed inventory models in this direction.

The efficiency of a supply chain management depends on active cooperation and close coordination between the vendor and the buyer. Goyal and Gupta, Lee et al., Weng [37, 60, 119] suggested that quantity discount was a coordination mechanism. For the buyer-vendor coordination, credit period is an effective mechanism. Luo [52] proved this fact. The adoption of integrated models (buyer and vendor) can contribute significantly to better buyer-vendor relationships. Gottardi and Bolisani [35] had this opinion. Banerjee and Banerjee [5] suggested that reducing ordering cost in a supply chain could streamline and speedup transactions via the application of information technology. Many researchers like Chang et al., Zhang et al., Woo et al., [11, 109, 121] advocated the desirability of an improved
relationship between a vendor and a buyer. Sarkar et al., [97] developed supply chain models for perishable items under inflation and delay in payments.

2.4 LITERATURE GAP

To the best of my knowledge there are no inventory models with partially backlogged shortages under trade credit in which (i) demand depends on time (ii) demand depends on stock and time (iii) demand, deterioration are nonlinear functions (explanation is given in page 3) of stock (iv) demand is an exponential function of initial net inventory level, autocorrelated and also price sensitive.

The inventory models with continuous review policy, mixture of back orders and reducible lead time, setup cost and yield variability with investments are not yet addressed.

There are no inventory models which study the effects of price discount and inflation on the profitability of a two echelon system having both defective and non-defective items.

Analysis, about the benefits of order cost reduction and credit period incentives in a coordinated supply chain, is not discussed.

2.5 SUMMARY

In this thesis we try to fulfill the above gaps. We have developed various inventory models for single item. We have considered different types of demand with concepts like partial backlogging, backorder price discount, inflation, investment in reducing lead time, setup cost and yield variability as in Figure 2a. We have also studied a two echelon system
having both defective and non-defective items. A coordinated supply chain with credit period incentives has also been discussed.