Journal of Advances in Science and Technology

Vol. IV, No. VII, November-2012, ISSN 2230-9659

CHEBYSHEV INEQUALITY AND MINIMAX DISTRIBUTION FREE PROCEDUR IN MIXED INVENTORY MODEL WITH EFFECTIVE INVESTMENT TO REDUCE LEAD TIME AND SETUP COST WITH IMPRECISE DEMAND

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Vol. IV, No. VII, November-2012, ISSN 2230-9659

Chebyshev Inequality and Minimax Distribution Free Procedur in Mixed Inventory Model with Effective Investment to Reduce Lead Time and Setup Cost with Imprecise Demand

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Abstract – In this paper, Fuzzy Economic Order Quantity (FEOQ) model is studied to determine the optimal order quantity, discount backordered cost and lead-time. Whole of the study is performed in fuzzy environment. Even today, most of the researchers are ignoring this concept, just for the sake of simplicity of their models. But due to globalization and cut throat competition, it is the need of the hour to study the inventory model in fuzzy environment. So that they can accurately analyze inventory parameters and hence increase the goodwill of the organization in market. This paper is a part of my Ph.D. thesis and included in my thesis as Chapter-4

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4.1 INTRODUCTION

Now-a-days managers of every organization recognize the fact that by managing risks associated in their business, they can successfully manage their inventories. One of the most common risks that have attracted significant attention of managers is supply uncertainty, especially the risk associated with direct material supplies and deliveries. This type of risk has escalated as fortune of 500 companies has sourced a great proportion of products from areas of the globe with low labor costs, such as China an India. Most of the companies recognize the significance of response time as a competitive weapon and have used time as means of differentiating themselves in the market place.

Lead-Time is the time difference between the placement of the order and receipt of it. In the competitive business environment, if a decision-maker can apply some means to reduce the lead-time, it would result in efficient service from the firms' point of view and it also improved the customer satisfaction. The lead-time reduction should be considered as a very significant variable in inventory control. Although, the lead-time can either be a constant or a variable, it was often treated as a prescribed parameter in most of the inventory model and consequently not controllable. Generally, it consists of the following components: order preparation/ processing time, order transit time to the supplier, supplier lead-time, items transit time from the supplier, and the time taken from the order receipt to its availability on the shelf. By optimizing these variables the lead-time can be reduced to its minimum level. This task can be achieved by inventing extra crashing cost. By shortening lead-time, the normal safety stock requirement can be reduced, and it is turn can minimize the out-of-stocks losses, improve the customer service level; and all these factors provide competitive advantages in business. Very few researchers have modified the traditional inventory models by incorporating reduction of lead-time by an extra crashing concept.

Generally, when the system is out of stock, cost and operations of inventory depends on what happens to demand, especially, for products with high sales value and/or high direct profitability, the cost of lost demand is high. The intention of a good modeler should always be to explore the possibility of improving the current system behaviors so as to minimize the total cost of maximize the total profit. Therefore, in addition to the traditional methods of using safety stock, certain possible ways that may prevent the loss caused by stock outs should be tried. There are many factors that affect the customer's willingness in accepting the backorder. It is well known fact that for some most desirable products or fashionable goods such as certain brand gum shoes and clothes, customers prefer to wait, in order to satisfy their demands. Another factor can be the price discount offered on the stock out items. It is observed that higher the price discount from the retailer, higher the advantages of the customer, and hence a large number of backorder ratio may result.

Table-4.1: Major Characteristics of Inventory Models by Selected Researcher:

References	Demand		Setup Cost		Solution Procedure		Shortage	Decision Variables
	Constant	Fuzzy	Constant	Reducibl	Minimax distributio n free	Chebyshe v		
Liao and shyu (1991)	Stochastic Demand		*				With Shortage	Lead-Time
Ben-Daya and Raouf (1994)	*		*				Partial Backorder	Lead-Time, Order Quantity
Ouyang et al. (1996)	*		*		*		Mixture of Backorder	Lead-Time, Order Quantity
Ouyang and Wn. (1998)	*		*		*		Mixture of Backorder	Lead-Time, Order Quantity
Hariga and Ben-Daya (1999)	*		*		*		Mixture of Backorder	Lead-Time, Order Quantity, Recorder Point
Ouyang and Chang (2002)	*		*		*		Fuzzy lost Sale	Lead-Time, Order Quantity, Recorder Point
Ouyang et al. (2003)	*		*		*		Discounted Backorder	Length of a review period, Backorder price discount
Cheng et al. (2004)	*		*		*		Discounted Backorder	Order Quantity, Backorder discount, Lead time
Uthayakumar (2008)	*			*	*		Discounted Backorder	Order Quantity, Backorder Price discount
Lin (2008)	*		*		*		Discounted Backorder	Length of review period Backorder rate, Lead-time
Lin (2009)	*			*	*		Discounted Backorder	Order quantity, Ordering cost, Backorder price discount, lead-time, Number of shipments
Lo (2009)	*		*		*		Discounted Backorder	Lead-time, Order quantity, Back-order discount, Safety factor
Annadurai and Uthayakumar (2010)	*			*	*		Mixture of Backorder	Order quantity, Lead-time, Setup cost
In Present Chapter		*		*	*		Discounted Backorder	Order Quantity, Backorder discount, Lead-time

The above survey and survey performed in chapter-2 revealed that most of the inventory practitioners used Minimax-distribution free procedure to solve their problems. A Chebyshev approach for solving the problems has been present by EI-Gindy et al. (1995). This technique is based on the expansion of the controllable variable in Chebyshev series with unknown coefficients. Very few inventory practitioners apply Chebyshev approach in inventory control system. In literature it was found that Maity et al. (2007) used that approach for solving as constraint optimization problem. Jaggi and Arneja (2011) developed a continuous review inventory model in crisp environment by assuming that demand distribution during lead-time is unknown and solved the model by two different approaches: Minimax-distribution free approach and Chebyshev inequality.

In the chapter, a mixed inventory model has been developed by applying the fuzzy set theory to deal with the impreciseness of demand rate. By doing so the proposed inventory model captures the inventory situation better. In fact, the application of fuzzy set concepts on EOQ inventory models have been proposed by many authors. However, their studies were almost concentrated on the simple EOQ models with restrictive assumptions. Most of them assumed lead-time as a constant and took shortages either completely backorder or totally lost. Because of that, those models have very few applications in inventory system. To increase the applicability of proposed model, a combination of backorder and lost sale with backorder price discount is considered. Crashing cost is also considered in this chapter to reduce the lead-time and setup cost. Cost expression is fuzzy due to the impreciseness in demand. Equivalent crisp expression is obtained by employing signed distance and centroid method. The backorder price discount, the lead-time and the order quantity are taken as decision variables (whereas the probability distribution of lead-time demand is unknown but its first two moments are known). Chebyshev inequality and Minimax-distribution free procedure are employed to minimize the annual cost.

4.2 ASSUMPTIONS AND NOTATIONS:

To develop in inventory model in this chapter, the following notations and assumptions are used.

4.2.1 ASSUMPTIONS:

1. Time horizon is finite.

2. Shortages allowed and backlogged partially.