Chapter 17
Two-Way Substitutable Inventory System with N-Policy

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ABSTRACT

This article presents a two commodity stochastic inventory system under continuous review. The maximum storage capacity for the i-th item is fixed as S_i (i = 1, 2). It is assumed that demand for the i-the commodity is of unit size and demand time points form Poisson distribution with parameter λ_i, i = 1, 2. The reorder level is fixed as s_i for the i-th commodity (i = 1, 2) and the ordering policy is to place order for $Q_i (= S_i - s_i)$ items for the i-th commodity (i = 1, 2) when both the inventory levels are less than or equal to their respective reorder levels. The lead time is assumed to be exponential. The two commodities are assumed to be substitutable. That is, if the inventory level of one commodity reaches zero, then any demand for this commodity will be satisfied by the item of the other commodity. If no substitute is available, then this demand is backlogged up to a certain level N_i, (i = 1, 2) for the i-th commodity. Whenever the inventory level reaches N_i, (i = 1, 2), an order for N_i items is replenished instantaneously. For this model, the limiting probability distribution for the joint inventory levels is computed. Various operational characteristics and expression for long run total expected cost rate are derived.

INTRODUCTION

In many practical multi-item inventory systems concentrated the coordination of replenishment orders for group of items. Now a days it is very much applicable to run a successful Business and Industries. These systems unlike those dealing with single commodity involve more complexities in the reordering procedures. The modelling of multi-item inventory system under joint replenishment has been receiving considerable attention for the past three decades.

In continuous review inventory systems, (Ballintfy, 1964) and (Silver, 1974) have considered a coordinated reordering policy which is represented by the triplet (S, c, s), where the three parameters S_i, c_i and s_i are specified for each item *i* with $s_i \leq c_i \leq S_i$, under the unit sized Poisson demand and constant lead time. In this policy, if the level of i-th com-

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modity at any time is below s_i, an order is placed for $S_i - s_i$ items and at the same time, any other item $j(\neq i)$ with available inventory at or below its can-order level c_j, an order is placed so as to bring its level back to its maximum capacity S_j. Subsequently many articles have appeared with models involving the above policy and another article of interest is due to (Federgruen, Groenevelt and Tijms, 1984), which deals with the general case of compound Poisson demands and non-zero lead times. A review of inventory models under joint replenishment is provided by (Goyal and Satir, 1989).

(Kalpakam and Arivarignan, 1993) have introduced (s, S) policy with a single reorder level s defined in terms of the total number of items in the stock. This policy avoids separate ordering for each commodity and hence a single processing of orders for both commodities has some advantages in situation where in procurement is made from the same supplies, items are produced on the same machine, or items have to be supplied by the same transport facility.

(Krishnamoorthy, Iqbal Basha and Lakshmy, 1994) have considered a two commodity continuous review inventory system without lead time. In their model, each demand is for one unit of first commodity or one unit of second commodity or one unit of each commodity 1 and 2, with prefixed probabilities. (Krishnamoorthy and Varghese, 1994) have considered a two commodity inventory problem without lead time and with Markov shift in demand for the type of commodity namely "commodity-1", "commodity-2" or "both commodity", using the direct Markov renewal theoretical results. And also for the same problem, (Sivasamy and Pandiyan, 1998) had derived various results by the application of filtering technique.

(Anbazhagan and Arivarignan, 2000) have considered a two commodity inventory system with Poisson demands and a joint reorder policy which placed fixed ordering quantities for both commodities whenever both inventory levels are less than or equal to their respective reorder levels.

(Anbazhagan and Arivarignan, 2001) have analyzed models with a joint ordering policy which places orders for both commodities whenever the total net inventory level drops to a prefixed level s.

(Anbazhagan and Arivarignan, 2004) have analysed models with individual and joint ordering policy. For the individual reorder policy, the reorder level for i-th commodity is fixed as r_i and whenever the inventory level of i-th commodity falls on r_i an order for P_i $(= S_i - r_i)$ items is placed for that commodity irrespective of the inventory level of the other commodity. A joint reorder policy is used with prefixed reorder levels s and order for Q_x^1 $(S_1 - x)$ and Q_y^2 $(S_2 - y)$ items is placed for both commodities by cancelling the previous orders, whenever both commodities have their inventory level drops to a reorder level s, ($x + y = s$).

In this paper the demand points for each commodity form independent Poisson processes and the lead times initiated by joint reorder policy are assumed to be independent and distributed as negative exponential. The two commodities are assumed to be substitutable. That is, if the inventory level of one commodity reaches zero, then any demand for this commodity will be satisfied by the item of the other commodity. If no substitute is available, then this demand is backlogged. The backlog is allowed upto the level N_i, (i = 1, 2) for the i-th commodity. Whenever the inventory level reaches N_i, (i = 1, 2), an order for N_i items are placed which is replenished instantaneously. The limiting probability distribution of the joint inventory level is derived. Various measures of system performance in the steady state are also obtained.

MODEL DESCRIPTION

Consider a two commodity stochastic inventory system with the maximum capacity S_i units for i-th commodity (i = 1, 2). The demand for i-th commodity is of unit size and the time points of demand occurrences form independent Poisson

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