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Using a Linear Price Dependent Demand Inventory Model for a Deteriorating Item

Rahul Mondal

Student

Department of Mathematics

Chhatrapati Shahu Maharaj College of Engineering and Technology

***Corresponding Author's Email id**: rahulmondal465@gmail.com*

Abstract

In this paper, an inventory model in a crisp environment is established. This is a model for nonmanufacturing inventories. Demand is assumed to be price sensitive. The rate of deterioration is assumed to remain constant. The model was created for the scenario of no shortage. For deterministic inventory parameters, profit and optimal order quantity are derived. The model is shown with numerical parameter values, and sensitivity analysis is offered.

***Keywords: -** Deterioration Price dependent demand; Inventory model*

INTRODUCTION

Demand and Deterioration are essential factors in Inventory Control Systems. Most traditional inventory models assumed that the inventory's usefulness remained constant over its storage duration. However, degradation does occur in storage in real life. In recent years, there has been a lot of focus on the issue of decaying inventories. Change, damage, decay, spoiling, evaporation, obsolescence pilferage, and loss of utility or loss of marginal value of a product that results in diminishing usefulness from the original one are all examples of degradation.

Most products, including medication, blood, seafood, alcohol, fuel, vegetables, and radioactive materials, have a limited shelf life and begin to degrade once replaced. Controlling and maintaining inventories of degrading commodities is thus a key concern

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confronting every modern supply management. Several scholars have studied ongoing degradation inventories in recent decades. The most important element in demand fluctuation is price. Begum et al. [5] devised a strategy of rapid replenishment for degrading products with price-dependent demand.

Bhuniaet al. [3] created an inventory model for decaying products based on selling price, frequency of marketing, and linearly time dependent demand with shortages. Profit maximisation EOQ model is established in this work in a clear context where the selling price of an item is set and known. The pace of deterioration is constant. The ideal value of the number of item to be ordered is calculated in this article, as well as the time point when inventory is to be restocked.

ASSUMPTIONS:

1. The scheduling period is constant
2. No lead-time.
3. Replenishment rate is infinite.
4. Demand rate is price dependent.
5. Shortages are not allowed

NOTATIONS:

1. Q(t) : Inventory level at time t
2. T : Time period of cycle
3. Ch : holding cost per unit
4. Cd : Deterioration cost per unit
5. P : Selling Price of item
6. C :purchasing cost per item.
7. R : Demand rate per item; [R=a-bp]
8. PF : Net Profit
9. θ: Deterioration rate

MATHEMATICAL ANALYSIS:

Q(t) is the inventory level at time t of the item, then the differential equation describing the

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state of inventory is given by

$$\frac{ddQQ(tt)}{ddtt} + \theta\theta * QQ(tt) = -(aa - bb * pp), oo \le tt \le TT$$

$$\frac{dd}{ddtt} ee^{-\theta\theta tt} * QQ(tt) = -(aa - bb * pp) ee^{-\theta\theta tt}, oo \le tt \le TT$$

$$QQ(tt) = -\frac{(aa - bb * pp)}{\theta\theta} + cc ee^{-\theta\theta tt}, oo \le tt \le TT$$

solving the above differential equation using boundary condition Q(t)=Q at t=o, we get ,

$$c = \frac{(a - b * p)}{\theta} + Q$$

$$Q(t) = -\frac{(a - b * p)}{\theta} + \left(\frac{(a - b * p)}{\theta} + Q\right) e^{-\theta t}, o \le t \le T$$

and using boundary condition Q(t)=0 at t=T in above equation we get

$$T = \frac{\log\left[1 + \frac{Q\theta}{(a - b * p)}\right]}{\theta}$$

$$\int_0^T Q(t) = -\frac{T * (a - b * p)}{\theta} + \frac{\left(\frac{(a - b * p)}{\theta} + Q\right)(1 - e^{-\theta T})}{\theta}$$

$$PF = (c - p) * Q - (Ch + \theta * Cd) * \int_0^T Q(t)$$

$$PF = (c - p) * Q - (Ch + \theta * Cd) * \left(-\frac{T * (a - b * p)}{\theta} + \frac{\left(\frac{(a - b * p)}{\theta} + Q\right)(1 - e^{-\theta T})}{\theta}\right)$$

Hence the problem is

$$\text{Max } PF = (c - p) * Q - (Ch + \theta * Cd) * \left(-\frac{T*(a-b*p)}{\theta} + \frac{\left(\frac{(a-b*p)}{\theta}+Q\right)(1-e^{-\theta T})}{\theta}\right)$$

Subject to

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$$T = \frac{\log\left[1 + \frac{Q\theta}{(a - b * p)}\right]}{\theta}$$

SENSITIVITY ANALYSIS:

Table 1. Effect of selling price 'p'

a	b	c	p	theta	ch	cd	PF	Q	T
100	0.5	10	3	0.05	2.2	2	1169.527	353.5897	3.301595
100	0.5	10	4	0.05	2.2	2	840.9367	294	2.795239
100	0.5	10	5	0.05	2.2	2	571.7189	237.8049	2.301387
100	0.5	10	6	0.05	2.2	2	358.3215	184.7619	1.819436

Table 2. Effect of 'a'

a	b	c	p	theta	ch	cd	PF	Q	T
100	0.5	10	6	0.05	2.2	2	358.3215	184.7619	1.819436
110	0.5	10	6	0.05	2.2	2	395.2618	203.8095	1.819436
150	0.5	10	6	0.05	2.2	2	543.0233	280	1.819436
200	0.5	10	6	0.05	2.2	2	727.7251	375.2381	1.819436
250	0.5	10	6	0.05	2.2	2	912.4269	470.4762	1.819436

Table 3. Effect of 'b'

a	b	c	p	theta	ch	cd	PF	Q	T
100	0.5	10	6	0.05	2.2	2	358.3215	184.7619	1.819436
100	0.7	10	6	0.05	2.2	2	353.8886	182.4762	1.819436
100	0.9	10	6	0.05	2.2	2	349.4558	180.1905	1.819436
100	1.1	10	6	0.05	2.2	2	345.023	177.9048	1.819436
100	1.3	10	6	0.05	2.2	2	340.5901	175.619	1.819436

CONCLUSION

1. Table 1 shows that when the selling price rises, so does the profit and the planning horizon.
2. Table 2 shows that when the value of 'a' grows, profit increases while the planning horizon remains constant.

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3. Table 3 shows that when the value of 'b' grows, profit declines while the planning horizon remains constant.

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