Integrated EPQ shortage inventory model with quantity discount

M. Babu[1] M. Ravithammal[2,*] and M. K. Vediappan[3]

1, 3. Assistant Professor, Department of Mathematics, Vels Institute of Science, Technology and Advanced Studies, Chennai – 600117, Tamil Nadu, India.

2. Associate Professor, Department of Mathematics, Vels Institute of Science, Technology and Advanced Studies, Chennai – 600117, Tamil Nadu, India.

ABSTRACT

This paper examines vendor - buyer EPQ (economic production quantity) model with shortage and quantity discount. To coordinate the supply chain of both the buyer and vendor along with their benefit analyses by the integrated model. To do a bulk purchase there could be an implementation in quantity discount process for vendor to buyer. To understand the proposed method this model includes detailed numerical examples.

Keywords: Production, Inventory, Order quantity, Shortages, Quantity discount.

1. INTRODUCTION

The aim of all manufacturing sector is to produce absolute quality goods. But are faced with problem like machinery inabilities, labor problem etc., Because of the shift in machinery system from in-control state to out-control state as a result, imperfect quality goods are produced by the manufacturing systems.

Jawla Singh [1] developed multi-item economic production quantity model for imperfect items with multiple production setups and rework under the effect of preservation technology and learning environment. Mari Selvi et al. [2] studied vendor-buyer integrated inventory model for controllable lead time with screening and disposed cost. Mohamad Y. Jaber and Ahmed M.A El Saadany [3] analyzed an economic production and remanufacturing model with learning effects. Muniappan and Uthayakumar [4] considered mathematical analyze technique for computing optimal replenishment polices. Muniappan et al. [5] studied a production inventory model for vendor–buyer coordination with quantity discount, backordering and rework for fixed life time products. Muniappan et al. [6] developed integrated inventory model for multi-echelon multi-constraints with quantity discount and coordination supply chain by using Lagrange multiplier technique. Muniappan et al. [7] concentrated EPQ incentive inventory model for deteriorating products involving partially backlogged shortages. Ravithammal et al. [8] studied obtaining inventory model for price discount with shortage. Ravithammal et al. [9] analyzed an pricing Model for deteriorating Items with positive exponential function of price discount rate of demand. Sugirtha Veda Selvi et al. [10] studied buyer – vendor inventory model for deteriorating items involving back orders, screening process and transportation cost.

2. NOTATIONS AND ASSUMPTIONS

The model use the following notations and assumptions

Notations

D	Demand rate
r_1	Buyer's unit ordering cost
r_2	Vendor's unit setup cost
P	Production cost
Q	Economic Order Quantity
h_b	Buyer's unit holding cost
h_v	Vendor's unit holding cost
C_s	Vendor's unit screening cost
C_d	Disposed cost
n	Vendor's multiples of order
s	Shortage cost
k	Buyer's multiples of order
d(k)	Discount factor
p	Purchase cost
u	Percentage of defecting items
v	Percentage of scrap items

Assumptions

(i) Demand rate is constant and known.
(ii) Shortages are occurring for buyer only.
(iii) Vendor produced the products and offers a quantity discount to the buyer.
(iv) Integrated system cost is developed for system optimization.

3. MODEL FORMULATION

The total cost for buyer contains ordering cost, holding cost, shortage cost and screening cost.

TC_b = Ordering cost + Holding cost + Shortage Cost+ Screening cost

i.e., $TC_b = \frac{r_1 D}{Q} + \frac{h_b Q_1^2}{2Q} + \frac{s(Q-Q_1)^2}{2Q} + \frac{C_s Q}{2}$ (1)

The total cost for vendor contains setup cost, holding cost, discount factor and disposed cost.

TC_v = Setup cost + Holding cost + Discount factor + Disposed cost

i.e., $TC_v = \frac{r_2 D}{nkQ} + \frac{h_v k(n-1)Q}{2}\left(1 - \frac{D}{P}\right) + pDd(k) + \frac{uv\ _d nQ}{2}$ (2)

Now, the integrated system cost is written as

$TC_s = TC_b + TC_v$

$$= \frac{r_1 D}{Q} + \frac{h_b Q_1^2}{2Q} + \frac{s(Q-Q_1)^2}{2Q} + \frac{C_s Q}{2} + \frac{r_2 D}{nkQ} + \frac{h_v k(n-1)Q}{2}\left(1 - \frac{D}{P}\right) + pDd(k) + \frac{uvC_d nQ}{2} \quad (3)$$

For optimality $\frac{\partial TC_s}{\partial Q_1} = 0$ and $\frac{\partial^2 TC_s}{\partial Q_1^2} > 0$ and $\frac{\partial TC_s}{\partial Q} = 0$ and $\frac{\partial^2 TC_s}{\partial Q^2} > 0$ we get,

$Q_1^* = \frac{sQ}{h_b + s}$ and

$$Q^* = \sqrt{\frac{2D(h_b + C_s)\left[r_1 + \frac{r_2}{nk}\right]}{sh_b + (h_b + C_s)\left[C_s + uvC_d + k(n-1)h_v\left(1 - \frac{D}{P}\right)\right]}} \quad (4)$$

4. NUMERICAL EXAMPLE

Let $R_1 = 500$ per order, $R_2 = 800$ per order, D = 1000 units per year, P = 2000, H_v = 0.06\$, H_b = 0.03\$, s_c = 0.02\$, s = 0.025\$, p = 0.6\$, n = 4, k= 3, d(k) = 15%.

The optimal solutions are

$Q^* = 2400.7$, $Q_1^* = 706.08$, $TC_s(Q^*, Q_1^*) = 562.09$

5. CONCLUSION

This paper examines on fixed life time product of buyer – vendor with quantity discount in the production inventory model. The supply chain of both the buyer and vendor are coordinated along with their benefit analyzed by the integrated model. Vendor supplied quantity deduction to the buyer for bulk purchase. For the developed model numerical examples are proposed. To proceed the research to a further level, the model can be extended in temporary discount, prize discount, multi products, credit period etc.,

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