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# An Integrated Stock Model For Purchaser – Seller With Price Discount And Shortage

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**Abstract.** This examination proposes stock model for purchaser – seller under decentralized and centralized circumstances. Under centralized circumstance integrated system cost is created for framework enhancement and ideal qualities are found by utilizing analytical geometry and algebraic technique. Our objective in this examination is to amplify the complete expense saving during the value markdown request cycle. A mathematical model is given to show the hypothesis.

**Keywords:** Inventory, Price Discount, Order Quantity, Analytical Geometry Technique, Algebraic Technique.

## 1. Introduction

The most well-known useful strategy for the provider to animate interest, increment portion of the overall industry and income, while lessening its stock of explicit things is to offer price discount to retailers. At the point when the provider offers a price discount for any of the above reasons, it is significant for the retailer to decide if it is beneficial to put in a unique forward purchasing request. (i.e., buy extra stock at the scaled down cost offered by the provider for a postponed deal at the standard selling cost).

Young-Bin Woo et al. [12] made production stock control model for a stock organization with economic production rates under no deficiencies permitted .Zhan et al. [13] thought about motivations through stock control in supply chains. Chang et al. [1] contemplated monetary request amount model for defective quality. Ravithammal et al. [8] separated stock model for esteem discount including lack, postpone buying and redo.

Muniappan et al. [5] fostered a creation stock model for fixed life time items including amount markdown, backordering and rework. Zhou et al. [14] encouraged EPQ models for things with defective quality and when just Discount.

Mari Selvi et al. [4] considered the derivation of EOQ/EPQ inventory models using analytic geometry and algebra. Muniappan et al. [7] concentrated a united cash related sales aggregate model including stock level and thing house limit essential. Ravithammal et al. [10] fostered order quantity design engaging algebraic method with inventory size requirement. Vediappan et al. [11] contemplated joined design for Buyer – Vendor utilizing lagrange multiplier strategy.

Li et al. [2] developed supplier – retailer design and carrier with price discount policy. Ravithammal et al. [9] developed an ideal evaluating model with positive striking restriction of huge worth markdown speed of interest. Muniappan et al. [6] cultivated production design including fairly expanded needs. Mahadi Tajbakhsh et al. [3] broke down a stock model with inconsistent markdown responsibilities.

## 2. NOTATIONS AND ASSUMPTIONS

The model uses the following notations and assumptions.

### 2.1 Notations

| | |
|---|---|
| $D$ | Demand rate |
| $H_v$ | Seller’s unit holding cost |
| $s_c$ | Seller’s unit screening cost |
| $n$ | Seller’s multiples of order |
| $R_1$ | Purchaser’s unit ordering cost |
| $R_2$ | Seller’s unit setup cost |
| $s$ | Purchaser’s unit shortage cost |
| $i$ | Inventory carrying charge |
| $p_j$ | Purchase cost per unit where $j = 1, 2, \ldots, n$. |
| $Q_1$ | Backorder level |
| $Q_j^*$ | Optimum Order quantity for decentralized model |
| $Q_{j0}^*$ | Optimum Order quantity for centralized model |

### 2.2 Assumptions

- Demand rate is known and consistent.
- Shortages are happening for purchaser only.
- Integrated system cost is formulated for system optimization.

- Price limits are offered if the purchaser ordered quantity is huge and the discount plan is given as follows
  $p_j = \{p_1, \quad 0 \le Q_1 \le b_1\ p_2, \quad b_1 \le Q_2 \le b_{2\,.....}\ p_n, \quad b_{n-1} \le Q_n \le b_n\ \}$

Here$p_n < p_{n-1} <\ldots< p_1$ and the price of item falls as the ordering quantity is $b_1, b_2 \ldots b_n$.

## 3. MODEL FORMULATION

In this section, both centralized and decentralized models are figured. In decentralized circumstances purchaser cost having ordering cost, holding cost and shortage cost and Seller cost having setup cost, holding cost and the screening cost. Under centralized circumstances integrated system cost is planned for framework advancement.

**Case (i) : Price discount Decentralized Model**

The total cost for purchaser and seller is communicated as follows

i.e., $TC_b = \frac{DR_1}{Q_j} + \frac{ip_jQ_1^2}{2Q_j} + \frac{s\left(Q_j - Q_1\right)^2}{2Q_j} + Dp_j$

(1)

Where, $p_j = \{p_1,\ 0 \le Q_1 \le b_1\ p_2,\ b_1 \le Q_2 \le b_{2\,.....}\ p_n,\ b_{n-1} \le Q_n \le b_n\ \}$

and $TC_v = \frac{DR_2}{nQ_j} + \frac{H_v nQ_j}{2} + \frac{s_c nQ_j}{2}$

(2)

Equation (1) can be composed as

$TC_b = Q_1^2\left[\frac{ip_j}{2Q_j} + \frac{s}{2Q_j}\right] + Q_1[-s] + \frac{DR_1}{Q_j} + \frac{sQ_j}{2} + Dp_j$

(3)

Equation (3) It is of the structure $a_1Q_1^2 + a_2Q_1 + a_3$.

$Q_1$ will be taken as, $Q_1 = \frac{-a_2}{2a_1}$

$Q_1 = \frac{sQ_j}{ip_j + s}$

(4)

Also, Equation (3) can be composed as

$TC_b = Q_j\left(\frac{s}{2}\right) + \frac{1}{Q_j}\left[DR_1 + \frac{ip_jQ_1^2}{2} + \frac{sQ_1^2}{2}\right] - sQ_1 + Dp_j$

(5)

It is of the structure $a_1 Q_j + \frac{a_2}{Q_j} + a_3$.

$Q_j$ will be taken as, $Q_j = \sqrt{\frac{a_2}{a_1}}$

$$Q_j = \sqrt{\frac{2DR_1(ip_j+s)}{ip_j s}}$$
(6)

**Plan technique for price discount decentralized model**

**Step 1:** Determination of optimum backorder level $Q_1$ by utilizing the condition (4).

**Step 2:** Finding optimum order quantity $Q_j$, j = 1, 2 ... n by utilizing the condition (6).

(i) Computing $Q_n$. If $Q_n \geq b_{n-1}$ then, optimum order quantity $Q_j = Q_n$.

(ii) If $Q_n < b_{n-1}$, then, find $Q_{n-1}$. If $Q_{n-1} \geq b_{n-2}$, then, $TC_b(Q_{n-1})$ refer with $TC_b(b_{n-1})$.

(ii) If $Q_n < b_{n-2}$, then, find $Q_{n-2}$. If $Q_{n-2} \geq b_{n-3}$ then, refer $TC_b(Q_{n-2})$ with $TC_b(b_{n-1})$.

(iii) If $Q_{n-2} < b_{n-2}$, then, find $Q_{n-3}$ . If $Q_{n-3} \geq b_{n-4}$, then, refer with, $TC_b(b_{n-3})$, $TC_b(b_{n-2})$ and $TC_b(b_{n-1})$.

(iv) Continuing in this manner, until $Q_{n-j} \geq b_{n-(j+1)}$, $0 \leq j \leq n-1$ and refer $TC_b(b_{n-j-2}) \ldots, \ldots, TC_b(b_{n-1})$.

**Step 3:** Finding $TC_b$ and $TC_v(Q_j)$ utilizing the conditions (1) and (2).

**Case (ii): Price discount Centralized Model**

The integrated system cost is communicated as follows

$$TC_s = TC_b + TC_v$$

$$= \frac{DR_1}{Q_{j0}} + \frac{ip_j Q_1^2}{2Q_{j0}} + \frac{s(Q_j - Q_1)^2}{2Q_{j0}} + Dp_j + \frac{DR_2}{nQ_{j0}} + \frac{H_v n Q_{j0}}{2} + \frac{s_c n Q_{j0}}{2}$$
(7)

Where, $p_j = \{p_1,\ 0 \leq Q_1 \leq b_1\ p_2,\ b_1 \leq Q_2 \leq b_{2\,\ldots\ldots}\ p_n,\ b_{n-1} \leq Q_n \leq b_n\}$

Equation (7) can be composed as

$$TC_s = \left(\frac{ip_j}{2Q_{j0}} + \frac{s}{2Q_{j0}}\right)Q_1^2 + [-s]Q_1 + \frac{DR_1}{Q_{j0}} + \frac{R_2D}{nQ_{j0}} + \frac{H_v nQ_{j0}}{2} + \frac{s_c nQ_{j0}}{2} + \frac{sQ_{j0}^2}{2Q_{j0}} + Dp_j$$
(8)

Equation (8) It is of the structure $a_1Q_1^2 + a_2Q_1 + a_3$.

$Q_1$ will be taken as, $Q_1 = \frac{-a_2}{2a_1}$

$$Q_1 = \frac{sQ_j}{ip_j+s} \quad (9)$$

Also, equation (8) can be composed as

$$TC_s = \left\{\frac{s}{2} + \frac{s_c n}{2} + \frac{H_v n}{2}\right\}Q_{j0} + \frac{1}{Q_{j0}}\left[DR_1 + \frac{ip_jQ_1^2}{2} + \frac{sQ_1^2}{2} + \frac{R_2D}{n}\right] + Dp_j - sQ_1$$
(10)

It is It is of the structure $a_1Q_j + \frac{a_2}{Q_j} + a_3$.

$Q_{j0}$ will be taken as, $Q_{j0} = \sqrt{\frac{a_2}{a_1}}$

Now, $$Q_{j0} = \sqrt{\frac{2D(ip_j+s)\left(R_1+\frac{R_2}{n}\right)}{(ip_j+s)[s+n(s_c+H_v)]-s^2}} \quad (11)$$

**Plan technique for price discount centralized model**

**Step 1:** Determination of optimum backorder level $Q_1$ by utilizing the condition (9).

**Step 2:** Finding optimum order quantity $Q_{j0}$, j = 1, 2 ... n by utilizing the condition (11).

(i) Computing $Q_n$. If $Q_n \geq b_{n-1}$ then, optimum order quantity $Q_{j0} = Q_n$.

(ii) If $Q_n < b_{n-1}$, then, find $Q_{n-1}$. If $Q_{n-1} \geq b_{n-2}$, then, $TC_s(Q_{n-1})$ refer with $TC_s(b_{n-1})$.

(iii) If $Q_n < b_{n-2}$, then, find $Q_{n-2}$ . If $Q_{n-2} \geq b_{n-3}$ then, refer $TC_s(Q_{n-2})$ with $TC_s(b_{n-1})$.

(iv) If $Q_{n-2} < b_{n-2}$, then, determining $Q_{n-3}$. If $Q_{n-3} \geq b_{n-4}$, then, refer with, $TC_s(b_{n-3})$, $TC_s(b_{n-2})$ and $TC_s(b_{n-1})$.

(v) Continuing in this manner, until $Q_{n-j} \geq b_{n-(j+1)}$, $0 \leq j \leq n-1$ and refer with $TC_s(b_{n-j-2})$ ……, $TC_s(b_{n-1})$.

**Step 3:** Determining $TC_s(Q_{j0})$ by utilizing the condition (7).

## 4. CONCLUSION

In this study, stock model for purchaser – seller with price discount policy under decentralized and centralized circumstances are considered. In centralized circumstances integrated system cost is made for identical help of purchaser and seller. In both circumstances the optimal backorder level and ideal order size are gotten by utilizing basic analytical geometry and algebraic procedures. For the further explores, the model can be reached out in credit period, impermanent rebate, multi-echelon supply chains, deferred installments, trade credit methodology and so on.

## REFERENCES

1. Chang, C.T., Cheng, M.C. and Soong, P.Y., **2016**. Impacts of inspection errors and trade credits on the economic order quantity model for items with imperfect quality. International Journal of Systems Science: Operations & Logistics, 3(1), pp.34-48.
2. Li, L., Wang, Y. and Dai, W., **2016**. Coordinating supplier retailer and carrier with price discount policy. Applied Mathematical Modelling, 40, pp. 646-657.
3. Mahadi Tajbakhsh, M., Lee., C. G. and Zolfaghari., S.,**2011**. An inventory model with random discount offerings. Omega39, pp. 710-718.
4. Mari Selvi, A., Ravithammal, M. and Muniappan, P., **2018**. Vendor-Buyer Integrated Inventory Model for Controllable Lead Time with Screening and Disposed Cost. Jour of Adv. Research in Dynamical & Control Systems, 10(5), pp. 636-638.
5. Muniappan, P., Uthayakumar, R. and Ganesh, S., **2016.** A production inventory model for vendor–buyer coordination with quantity discount, backordering and rework for fixed life time products. Journal of Industrial and Production Engineering, 33, pp. 355–362.
6. Muniappan, P., Ravithammal, M. and Ameenammal, A., **2018.**EPQ incentive inventory model for deteriorating products involving partially backlogged shortages. Jour of Adv Research in Dynamical & Control Systems, 10(6), pp. 940-943.
7. Muniappan, P., Ravithammal, M. and Haj Meeral, M., **2020.**An Integrated Economic Order Quantity Model Involving Inventory Level and Ware House Capacity Constraint. International Journal of Pharmaceutical Research, 12(3), pp. 791-793.
8. Ravithammal, M., Uthayakumar, R. and Ganesh, S., **2017.** Obtaining inventory model for price discount with shortage, back ordering and rework. Asia Life Science, 14, pp. 25-32.
9. Ravithammal, M., Muniappan, P. and Uthaya kumar, R., **2018.**An Optimal Pricing Inventory Model for Deteriorating Items with Positive Exponential Function of Price

Discount Rate of demand. Jour of Adv Research in Dynamical & Control Systems, 10(5), pp. 639-645.

10. Ravithammal, M., Muniappan, P. and Hemamalini, S., **2019.**EOQ inventory model using algebraic method with inventory level constraint. Journal of International Pharmaceutical Research, 46(1), pp. 813-815.
11. Vediappan, M. K., Ravithammal, M. and Muniappan, P., **2019.**Integrated Coordination Inventory Model for Buyer – Vendor Using Lagrange Multiplier Technique. Jour of Adv Research in Dynamical & Control Systems, 11(1), pp. 283 – 287.
12. Young-Bin Woo., ilkyeong Moon. and Byung Soo Kim., **2021**. Production-Inventory control model for a supply chain network with economic production rates under no shortages allowed. Computers & Industrial Engineering, 160, 107558.
13. Zhan., Qu, Horst., Raff. and Nicolas., Schmitt, **2018**. Incentives through inventory control in supply chains. International Journal of Industrial Organization59. pp. 486-513.
14. Zhou, Y.W., Chen, Z. J., Wu, Y. Z. and Zhou, W., **2015.** EPQ models for items with imperfect quality and one-time-only Discount. Applied Mathematical Modelling 39, pp. 1000-1018.