International Journal of Pure and Applied Mathematics
Volume 115 No. 5 2017, 1025-1030
ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
doi: 10.12732/ijpam.v115i5.3

ijpam.eu

VENDOR-BUYER COORDINATION MODEL WITH SHORTAGES AND SCREENING PROCESS

S. Ganesh[1 §], M.K. Vediappan[2], K. Srinivasan[3]

[1]Department of Mathematics
Sathyabama University
Chennai, 600119, Tamil Nadu, INDIA

[2,3]Department of Mathematics
Vels University
Chennai, 600117, Tamil Nadu, INDIA

Abstract: The paper specifies deterministic inventory model for vendor - buyer with coordination and non coordination situations. In coordinate situation, the vendor provides quantity discount to the buyer for bulk purchase. In both situations total cost is developed for both buyer and vendor and order quantity is determined by analytically tractable solutions. This study is made to determine the optimal order quantity to lesser the total inventory costs. Numerical examples are provided to revels the developed model.

AMS Subject Classification: 90B05, 65K10

Key Words: inventory, coordination, order quantity, screening cost

1. Introduction

Minimize the total inventory costs (setup cost, ordering cost, holding cost and shortage cost) is the main objective of traditional inventory models. Inventory models have lot of real time applications since we can implement these models easily in the organization. In inventory management some mechanism are

Received: April 29, 2017
Revised: May 23, 2017
Published: July 16, 2017

[§]Correspondence author

implemented to coordinate buyer and vendor. The mechanisms are quantity discount, sales rebit, trade credit, revenue sharing etc., Quantity discount is the best mechanism when it compared with the others.

Yoo et al. [10] developed inventory models for imperfect production and inspection processes with various inspection options under one-time and continuous improvement investment. Sana [8] studied economic production lot size model in an imperfect production system. Khan et al. [3] analyzed economic order quantity (EOQ) for items with imperfect quality and inspection errors. J. T. Hsu and L. F. Hsu [2] studied two EPQ models with imperfect production processes, inspection errors, planned backorders, and sales returns. Chang et al. [1] developed impacts of inspection errors and trade credits on the economic order quantity model for items with imperfect quality. Tiwari et al. [9] analyzed impact of trade credit and inflation on retailer's ordering policies for non-instantaneous deteriorating items in a two-warehouse environment. Ravithammal et al. [7] developed EPQ model for perishable items with fixed and linear backorders. Muniappan and Uthayakumar [4] studied mathematical model for computing optimal replenishment polices. Ravithammal et al. [6] studied EPQ inventory model for buyer- manufacturer with quantity discount and completely backlogged shortages for fixed life time product. Muniappan et al. [5] developed EPQ inventory model for vendor-buyer coordination with quantity discount, backordering and rework for fixed life time products. The rest of the paper is organized as follows. In the next section, notations and assumption are given. In Section 3, model formulation is given. In Section 4, numerical examples illustrate the developed model. Finally conclusion and summary are presented.

2. Assumptions and Notations

The model use the following notations and assumptions.

Notations:

D Demand rate per time unit
R_1 Buyer's unit ordering cost per order
R_2 Vendor's unit setup cost per order
s Buyer's unit shortage cost per order
p Buyer's unit purchase cost per order
Q Economic Order quantity
Q_1 Backorders level
H_b Buyer's unit holding cost per order per unit

H_v Vendor's unit holding cost per order per unit
s_c Vendor's unit screening cost per order per unit
n Vendor's multiples of order without coordination
m Vendor's multiples of order with coordination
k Buyer's multiples of order with coordination
$d(k)$ Discount factor

Assumptions

(i) Demand rate is constant.

(ii) Without coordination scheme buyer having shortages and with coordination scheme no shortages are occurring.

(iii) Without coordination vendor screened the damaged items and with coordination buyer screened the damaged items for resale.

3. Model Formulation

In this section, model formulation for system is developed for with and without coordination. Without coordination scheme, buyer has shortages and vendor screened the damaged products. In coordination scheme, the buyer order quantity is large than regular quantity because the vendor offers quantity discount to the buyer. Hence, the buyer has no shortage and he himself screened the damaged products for resale.

Model Formulation: Without coordination

The total cost for buyer contains, ordering cost $\frac{R_1 D}{Q}$, holding cost $\frac{H_b Q_1^2}{2Q}$ and shortage cost $\frac{s(Q-Q_1)^2}{2Q}$.
Thus, total cost for buyer can be written as

$$TC_b = \text{Ordering cost} + \text{Holding cost} + \text{Shortage Cost} \tag{3.1}$$

$$= \frac{R_1 D}{Q} + \frac{H_b Q_1^2}{2Q} + \frac{s(Q-Q_1)^2}{2Q} \tag{3.2}$$

The total cost for vendor contains the setup cost $\frac{R_2 D}{nQ}$, the holding cost $\frac{H_v nQ}{2}$ and the screening cost $\frac{s_c nQ}{2}$.

Thus, total cost for vendor can be written as

$$TC_v = \text{Setup cost} + \text{Holding cost} + \text{Screening Cost} \tag{3.3}$$
$$= \frac{R_2 D}{nQ} + \frac{H_v nQ}{2} + \frac{s_c nQ}{2} \tag{3.4}$$

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

$$Q_1^* = \frac{sQ}{H_b + s} \tag{3.5}$$

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

$$Q^* = \sqrt{\frac{2R_1 D}{sH_b}} \tag{3.6}$$

Model Formulation: With coordination

The total cost for buyer contains, ordering cost $\frac{R_1 D}{Q_c}$, holding cost $\frac{H_b Q_c}{2}$ and screening cost $\frac{s_c Q_c}{2}$.

Thus, total cost for buyer can be written as

$$TC_{b1} = \text{Ordering cost} + \text{Holding cost} + \text{Shortage Cost} \tag{3.7}$$
$$= \frac{R_1 D}{Q_c} + \frac{H_b Q_c}{2} + \frac{s_c Q_c}{2} \tag{3.8}$$

The total cost for vendor contains, setup cost$\frac{R_2 D}{knQ_c}$, holding cost $\frac{H_v knQ_c}{2}$ and buyer's quantity discount $pDd(k)$. Thus, total cost for vendor can be written as

$$TC_{v1} = \text{Setup cost} + \text{Holding cost} + \text{Buyer's discount factor} \tag{3.9}$$
$$= \frac{R_2 D}{knQ_c} + \frac{H_v knQ_c}{2} + pDd(k) \tag{3.10}$$

For optimality $\frac{\partial TC_{b1}}{\partial Q_c} = 0$ and $\frac{\partial^2 TC_{b1}}{\partial Q_c^2} > 0$ we get,

$$Q_c^* = \sqrt{\frac{2R_1 D}{H_b + s_c}} \tag{3.11}$$

4. Numerical Examples

Example 1. Let $R_1 = 300$ per order, $R_2 = 100$ per order, $D = 1000$ units per year, $H_v = 2\$$, $H_b = 20\$$, $s_c = 2\$$, $s = 25\$$, $p = 5\$$, $n = 2$, $m = 3$, $k = 2$, $d(k) = 5\%$.

The optimal solutions are $Q^* = 34.64$, $Q_1^* = 19.25$, $TC_b(Q^*, Q_1^*) = 8.8527X10^3$, $TC_v(Q^*, Q_1^*) = 1.5819X10^3$ $Q_c^* = 115.47$, $TC_{b1}(Q_c^*) = 3.8682X10^3$, $TC_{v1}(Q_c^*) = 1.0872X10^3$.

Example 2. Let $R_1 = 400$ per order, $R_2 = 200$ per order, $D = 1500$ units per year, $H_v = 4\$$, $H_b = 25\$$, $s_c = 25\$$, $s = 25\$$, $p = 5\$$, $n = 3$, $m = 4$, $k = 2$, $d(k) = 10\%$.
The optimal solutions are
$Q^* = 43.82$, $Q_1^* = 21.91$, $TC_b(Q^*, Q_1^*) = 1.3967X10^4$,
$TC_v(Q^*, Q_1^*) = 3.8176X10^3$ $Q_c^* = 154.92$, $TC_{b1}(Q_c^*) = 5.9644X10^3$,
$TC_{v1}(Q_c^*) = 3.5918X10^3$.

5. Conclusion

In this paper, vendor - buyer inventory model for deteriorating items is developed under screening process. Shortages are permitted in this inventory system for buyer only under non coordination situation. The damaged items are screened for resale by the vendor for non coordination situation and buyer for coordination situation. To compare with non coordination, quantity discount coordination situation proves equal benefits of buyer and vendor. Our objective is to find the optimal order quantity to minimize the total inventory cost. Numerical examples are also provided to illustrate the proposed model. For the further researches, our proposed model can be extended in considering time, price or stock-dependent demand rate, credit period, quantity discounts, temporary discounts etc.,

References

[1] C.T. Chang, M.C. Cheng, & P.Y. Soong, 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**(2016), 34-48.

[2] J.T. Hsu, &L.F. Hsu, Two EPQ models with imperfect production processes, inspection errors, planned backorders, and sales returns. Computers & Industrial Engineering, **64**(2013), 389-402.

[3] M. Khan, M.Y. Jaber,& M. Bonney, An economic order quantity (EOQ) for items with imperfect quality and inspection errors. International Journal of Production Economics, **133**(2011), 113-118.

[4] P.Muniappan, R.Uthayakumar, Mathematical analyze technique for computing optimal replenishment polices, International Journal of Mathematical Analysis, **8** (2014), 2979 - 2985.

[5] P.Muniappan, R.Uthayakumar and S. Ganesh, 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**(2016), 355-362.

[6] M. Ravithammal, R. Uthayakumar and S. Ganesh, A deterministic production inventory model for buyer- manufacturer with quantity discount and completely backlogged shortages for fixed life time product. Global Journal of Pure and Applied Mathematics, **11**(2015), 3583-3600.

[7] M. Ravithammal, R.Uthayakumar and S.Ganesh, An Integrated Production Inventory System for Perishable Items with Fixed and Linear Backorders, International Journal of Mathematical Analysis, **8**(2014), 1549 - 1559.

[8] S.S.Sana, An economic production lot size model in an imperfect production system. European Journal of Operational Research, **201**(2010), 158-170.

[9] S.Tiwari, L.E.Crdenas-Barrn, A.Khanna, & C.K.Jaggi, Impact of trade credit and inflation on retailer's ordering policies for non-instantaneous deteriorating items in a two-warehouse environment.International Journal of Production Economics, **176**, 154-169.

[10] S.H. Yoo, D. Kim,& M.S. Park, Inventory models for imperfect production and inspection processes with various inspection options under one-time and continuous improvement investment. Computers & Operations Research, **39**(2012), 2001-2015.