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# Deterministic Inventory Model for Deteriorating Items with Transportation Cost and Screening Process

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**Abstract:** In this paper, we develop a deterministic inventory model for deteriorating products with transportation cost. The model allows screening process for damaged products for resale. The demand rate is assumed to be deterministic and shortages are allowed to the inventory system. In this model, we determine the optimal back orders and optimal order quantity to minimizing the total relevant cost.

**Key words:** Inventory · Backorder · Order quantity · Transportation cost · Screening process

## INTRODUCTION

Supply chain is not limited to delivering products to the end-costumers since the damaged products that are returned back to the vendors by the buyers. The vendors should be great knowledge to utilize the damaged products effectively so as to maintain our natural resources and to provide better service to buyers. In this supply chain system, the damaged products are returned back and screened at a cost to become the perfect one.

L.H. Chen and F.S. Kang [1] developed coordination between vendor and buyer considering trade credit and items of imperfect quality. Hung – Chi [2] studied a comprehensive note on: An Economic order quantity with imperfect quality and quantity discounts. Mohamad Y. Jaber, Ahmed M.A. El Saadany [3] developed an economic production and remanufacturing model with learning effects. P. Muniappan *et al*. [4] concentrated a production inventory model for vendor–buyer coordination with quantity discount, backordering and rework for fixed life time products. P. Muniappan *et al.* [5] studied an optimal inventory model for a deteriorating item with time - dependent quadratic demand and delay in payment for two warehouses. M. Ravithammal *et al*. [6] developed buyer - Vendor incentive inventory model with fixed lifetime product with fixed and linear back orders. M. Ravithammal *et al*. [7] studied a deterministic production inventory model for buyer- manufacturer with quantity discount and completely backlogged shortages for fixed life time product. M. Ravithammal *et al*. [8] analyzed an Integrated Production Inventory System for Perishable Items with Fixed and Linear Backorders. Victor B. Kreng and Shao - Jung Tan [9] developed optimal replenishment decision in an EPQ model with defective items under supply chain trade credit policy. Yuan-Shyi Peter Chiu *et al*. [10] developed mathematical modeling for determining the replenishment policy for EMQ model with rework and multiple shipments.

The detailed description of the paper is as follows. In section 2, notations, assumption and formulation of the model are given. Finally conclusion and summary are presented.

**Formulation of the Model:** The model use the following notations and assumptions

**Notations**

D Demand rate per time unit
B Backorders level
Q Economic Order quantity
$c_3$ Vendor's unit setup cost per order
h Vendor's unit holding cost per order per unit
b Vendor's unit backorder cost per order per unit
s Vendor's unit screening cost per order per unit
F Vendor's fixed transportation cost per delivery
v Vendor's unit variable cost for order handling and receiving

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**Assumptions:**

(i) Demand rate is constant uniform.
(ii) There is no lead time.
(iii) Shortages are allowed.
(iv) Vendor screened the damaged items for resale.

**Model Formulation:** The total annual cost for the vendor consists following five parts:

(i) Annual setup cost $\frac{c_s D}{Q}$
(ii) Annual holding cost $\frac{h(Q-B)^2}{2Q}$
(iii) Back order cost $\frac{bB^2}{2Q}$
(iv) Screening cost $\frac{sQ}{2}$ and
(v) Transportation cost $F + vQ$

Thus the total cost for Vendor can be written as

TC = Setup cost + Holding cost + Back order cost + Screening cost + Transpotation cost

$$= \frac{c_s D}{Q} + \frac{h(Q-B)^2}{2Q} + \frac{bB^2}{2Q} + \frac{sQ}{2} + F + vQ \qquad (1)$$

Now $\frac{\partial TC}{\partial B} = \frac{-h(Q-B)}{Q} + \frac{Bb}{Q}$ and $\frac{\partial^2 TC}{\partial B^2} = \frac{h}{Q} + \frac{b}{Q}$

$\frac{\partial TC}{\partial Q} = \frac{-c_s D}{Q^2} + \frac{h(Q^2-B^2)}{2Q^2} - \frac{bB^2}{2Q^2} + \frac{s}{2} + v$

and $\frac{\partial^2 TC}{\partial Q^2} = \frac{2c_s D}{Q^3} + \frac{hB^2}{Q^3} + \frac{bB^2}{Q^3}$

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

$$B^* = \frac{hQ}{h+b} \qquad (2)$$

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

$$Q^* = \sqrt{\frac{2Dc_s(h+b)}{(h+b)(s+2v)+bh}} \qquad (3)$$

**Numerical Examples**

**Example 1:** Let $c_3$ = 50$ per order, D = 150 units per year, h = 0.4$, b = 0.2$, s = 0.1$, F = 0.5$, v = 1$.
From equations (1), (2) and (3) the optimal solutions are

B = 447.76, Q* = 671.64, TC = $2.0199 \times 10^{10}$

**Example 2:** Let $c_3$ = 100$ per order, D = 200 units per year, h = 0.8$, b = 0.3$, s = 0.2$, F = 0.5$, v = 2$.
From equations (1), (2) and (3) the optimal solutions are

B = 658.44, Q* = 905.35, TC = $8.0954 \times 10^{10}$

## CONCLUSION

In this paper we have study deterministic inventory model for deteriorating items with transportation cost and screening process. Backorders are allowed in this inventory system and the damaged products are screened by resale. The main goal of this study is to find the optimal variables such that the total system cost is minimized. Numerical examples are also provided to illustrate the developed model. For further research the model can be extended to some practical situations such as, quantity discount, temporary discount, different types of demands, credit periods etc.,

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