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ScienceDirect
European Journal of Operational Research 180 (2007) 1130–1134
EUROPEAN JOURNAL OF OPERATIONAL RESEARCH
www.elsevier.com/locate/ejor

Production, Manufacturing and Logistics

A note on a single-vendor and multiple-buyers production-inventory policy for a deteriorating item

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Received 18 October 2004; accepted 11 January 2006
Available online 4 August 2006

Abstract

In this note we examine the total cost function of a single-vendor multiple-buyers production-inventory policy for a deteriorating item by Yang and Wee [P.C. Yang and H.M. Wee, A single-vendor multiple-buyers production-inventory policy for a deteriorating item, European Journal of Operational Research 143 (2002) 570–581]. Two possible flaws in the cost function of Wee and Yang's model are pointed out. A proposal to eradicate the flaws is given.

Keywords: Deterioration; Production-inventory model; Replenishment policy

1. Introduction

In our note, we give some insight on the holding cost function in Yang and Wee [1] (noted as YW). They proposed the vendor's inventory level (Eqs. (1) and (2)), the buyer's inventory level (Eq. (3)), and the vendor's total holding cost functions (Eq. (4)) as follows:

$$I_{V1}(t_1) = \frac{p - \sum_{i=1}^{N} d_i}{\theta}[1 - \exp(-\theta \cdot t_1)], \quad 0 \leqslant t_1 \leqslant T_1, \tag{1}$$

$$I_{V2}(t_2) = \frac{\sum_{i=1}^{N} d_i}{\theta}\left[\frac{\exp(\theta \cdot T_2 - \exp(\theta \cdot t_2))}{\exp(\theta \cdot t_2)}\right], \quad 0 \leqslant t_2 \leqslant T_2, \tag{2}$$

$$I_{bi}(t) = \frac{d_i}{\theta}\left[\frac{\exp(\theta \cdot T/n_i - \exp(\theta \cdot t))}{\exp(\theta \cdot t)}\right], \quad 0 \leqslant t \leqslant \frac{T}{n_i}, \ \ i = 1, 2, \ldots, N \tag{3}$$

and

$$HC^{\text{YW}}_{V_{\text{vendor}}} = \frac{C_V F_V}{T}\left[\left(\int_0^{T_1} I_{V1}(t_1)\,\mathrm{d}t_1 + \int_0^{T_2} I_{V2}(t_2)\,\mathrm{d}t_2\right) - \sum_{i=1}^{N} n_i \int_0^{\frac{T}{n_i}} I_{bi}(t)\,\mathrm{d}t\right]. \tag{4}$$

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doi:10.1016/j.ejor.2006.01.050

Table 1
Optimal values of the revised model

n_1	n_2	$T_2(10^{-4})$	$T_1(10^{-4})$	$T(10^{-4})$	BC	VC	TC
1[a]	1[a]	1318	85	1403	30247.85	46575.43[a]	76623.28
1	2	1470	94	1564	24185.90	47288.91	71474.81
2	1	1401	90	1491	28293.92	46639.04	74932.96
2	2	1576	101	1678	21120.48	47919.63	69040.10
2[b]	3[b]	1665	107	1772	17073.06[b]	48534.70	67607.76
2	4	1727	111	1838	18466.62	48894.80	67361.42
3	3	1727	111	1838	18464.07	48894.31	67358.37
3[c]	4[c]	1791	115	1907	17657.81	49363.44	67021.23[c]
3	5	1843	119	1962	17494.14	49690.92	67185.06
4	3	1773	114	1887	18649.85	49083.39	67733.24
4	4	1839	118	1958	17702.72	49628.37	67331.08
4	5	1892	122	2013	17433.01	50012.21	67445.22
5	4	1879	121	2000	18086.39	49810.42	67896.68
6	4	1915	123	2038	18631.32	49953.32	68584.64

[a] The vendor's optimal solution of n_1 and n_2 that minimizes VC.
[b] The buyer's optimal solution of n_1 and n_2 that minimizes BC.
[c] The integrated optimal solution of n_1 *and* n_2 that minimizes TC.

Table 2
Comparison of vendor's holding cost function between YW's model and proposed model

	YW's cost function		Proposed cost function	
	PHC	TQE[a]	PHC	TQE[a]
Optimal solution drawn from YW's optimal solution ($n_1 = 1, n_2 = 1, T_1 = 0.0104, T_2 = 0.1610$)	−940.47	10323.44	14567.54	0
Optimal solution drawn from *proposed* model ($n_1 = 1, n_2 = 1, T_1 = 0.0085, T_2 = 0.1318$)	−767.85	8453.05	11918.20	0

[a] Difference between the total TWI and the sum of the vendor and the buyer's TWI.

In Eq. (1) of YW's model, since the demand rate has been considered in the differential equation, it is not necessary to subtract the buyer's TWI. Moreover, from Appendix A, YW's holding cost function violates the positive holding cost (PHC) characteristic. The total-quantity equality (TQE) characteristic is also violated because the total inventory carried by the vendor and the buyer is not equal to the total item quantities produced by the vendor (see (A.8) and (A.10)). Instead of Eq. (4), the revised vendor's time-weighted inventory (TWI) should be

$$\mathrm{TWI}_{\mathrm{vendor}}^{\mathrm{note}} = \frac{1}{T}\left(\int_0^{T_1} I_{V1}(t_1)\,\mathrm{d}t_1 + \int_0^{T_2} I_{V2}(t_2)\,\mathrm{d}t_2\right). \tag{5}$$

It is easily seen that the value of Eq. (5) is positive. Therefore, Eq. (5) satisfies the PHC characteristic. The model using the revised holding cost function, Eq. (5), is compatible with the TQE characteristic (see (A.12)). The optimal solution using our proposed holding cost function is shown in Table 1.

When Eq. (4) is used, a simple numerical example shows that the vendor's holding cost function in Yang and Wee [1] violates PHC and TQE characteristics. When Eq. (5) is used, the difference and deficiencies do not exist. The results are shown in Table 2.

Acknowledgements

We would like to express our appreciation to the editor and the referees for their contributions in improving the quality of the paper, and the National Science Council of Taiwan and CYCU for the research grant.