ELSEVIER

Int. J. Production Economics 65 (2000) 289–294

international journal of production economics

www.elsevier.com/locate/dsw

A note on JIT purchasing vs. EOQ with a price discount: An expansion of inventory costs

Marc J. Schniederjans*, Qing Cao

Department of Management, College of Business Administration. University of Nebraska-Lincoln, Lincoln, NE 68588-0491, USA

Received 30 October 1998; accepted 21 April 1999

Abstract

In a previous International Journal of Production Economics article, a comparative model was presented for inventory costs of purchasing under economic order quantity (EOQ) with quantity discounts and a just-in-time (JIT) order purchasing system. This paper expands the comparative model to include a relevant cost component not considered in the previous article. The results of the revised model show differences in the conclusions reached in the previous article, more specifically, the superiority of JIT in virtually any type of inventory ordering purchase decision.

Keywords: JIT; EOQ; Price discount; Purchasing; Cost comparison

1. Introduction

In Fazel et al. [1], a comparative cost function was presented that proposed to show where inventory ordering under an economic order quantity (EOQ) system or a just-in-time (JIT) system would be the most cost effective. They proposed a total cost difference function, Z that had two components given by

$$Z = \mathrm{TC_E} - \mathrm{TC_J}, \tag{1}$$

where $\mathrm{TC_E}$ is the total annual cost using an EOQ system for inventory ordering and $\mathrm{TC_J}$ is the total annual cost using a JIT system for inventory ordering. The total EOQ cost function component, $\mathrm{TC_E}$, for their proposed model was classically given by

$$\begin{aligned}\mathrm{TC_E} = {} & \text{Annual orderingcost} \\ & + \text{Annual holding cost} \\ & + \text{Annual purchasing cost.}\end{aligned}$$

The resulting cost function formula was given by

$$\mathrm{TC_E} = \frac{kD}{Q} + \frac{Qh}{2} + (P_E^0 - \pi_E Q)D \quad \text{for } Q \leqslant Q_{\max}, \tag{2}$$

where k is the cost of placing an order, D is annual demand, Q is order quantity, h is the annual inventory carrying cost per unit, P_E^0 is the purchasing cost per unit under an EOQ system, π_E is a constant representing rate at which the price of the item decreases with increase in order quantities, $Q_{\max}$ is the maximum quantity that can be purchased and

* Corresponding author. Tel.: + 1-402-472-6732; fax: + 1-402-472-5855.

E-mail address: mschniederjans1@unl.edu (M.J. Schniederjans)

0925-5273/00/$ - see front matter
PII: S0925-5273(99)00078-X

still receive a quantity discount whose rate is π_E. Taking the derivative of Eq. (2) with respect to Q, the resulting optimal order quantity, Q^*, is

$$Q^* = \sqrt{\frac{2kD}{h - 2\pi_E D}}. \tag{3}$$

For order quantities above Q_{max} the minimum quantity purchase price of P_E^{min} remains constant and the TC_E function becomes

$$TC_E = \frac{kD}{Q} + \frac{Qh}{2}(P_E^{min})D \quad \text{for } Q > Q_{max}. \tag{4}$$

Taking the derivative of Eq. (4) with respect to Q, the resulting optimal order quantity, Q^{**}, is

$$Q^{**} = \sqrt{\frac{2kD}{h}}. \tag{5}$$

The JIT total cost function, TC_J, for the proposed JIT portion of the model in Eq. (1), was limited to just the annual purchasing cost component in Eq. (2). The JIT total cost function is given by

$$TC_J = \text{Annual purchasing cost}, \quad \text{or}$$

$$TC_J = P_J D, \tag{6}$$

where P_J is the product unit price under a JIT system. Here they assumed, based on their personal experience with JIT and a brief literature review [2], that the annual ordering costs and the annual holding costs where either negligible or transferred to suppliers, thereby being incorporated into the annual purchasing cost component of the function.

Since EOQ or large lot operations usually avail themselves of the quantity discount advantage, the focus of Fazel et al. [1] was on developing cost functions that would show where EOQ and JIT operations would be the least cost strategy. Specifically, a cost function that was valid for $Q \leqslant Q_{max}$. The authors accomplished this by developing a total cost-difference function, Z, by substituting Eqs. (2) and (3) into Eq. (1), to derive

$$Z = kD\sqrt{\frac{h - 2\pi_E D}{2kD}} + \frac{h}{2}\sqrt{\frac{2kD}{h - 2\pi_E D}} + \left[P_E^0 - \pi_E\sqrt{\frac{2KD}{h - 2\pi_E D}}\right]D - P_J D. \tag{7}$$

For computed values of Z that are positive, the JIT system is less costly and for negative values of Z the EOQ is the least cost ordering system. Setting $Z = 0$ in Eq. (5) and solving for D, they derived the indifference point, D_{ind}, in which total annual cost of the EOQ system equals that of the JIT system, yielding

$$D_{ind} = \frac{2kh}{(P_J - P_E^0)^2 + 4k\pi_E}. \tag{8}$$

The economic value of D_{ind} is significant in that it denotes the point at which unit demand determines the superiority of the EOQ system over the JIT system. Fazel et al. [1] went on to demonstrate with an example, that at certain level of D, the EOQ system of ordering inventory was more cost-effective than a JIT system. It is important to note that the authors acknowledged that Q^* is real only when $(h - 2\pi_E D) > 0$.

2. The revised model

We agree with Fazel et al. [1] that Eqs. (2)–(5) represent the classic "quantity discount model" from the family of EOQ models originally proposed by Harris [3]. This same basic model is found in virtually every inventory management textbook. Yet, it should be noted that the quantity discount model gives the EOQ system the advantage of a price break that is not available to the JIT system. No equally obvious cost advantage was given to the JIT cost function when, in practice, one very obvious cost advantage does exist for a JIT system. This cost advantage is the facility size reduction that occurs in the inventory storage and production areas as a result of adopting a JIT system.

Past and present research on JIT system has clearly documented the inevitable reduction in facility square feet. The reduction in facility square footage is caused by the elimination of the space required to store incoming inventory, work-in-process inventory, and finished-goods inventory. JIT experts, such as Schonberger [4, pp. 121–122] and Wantuck [5, p. 16], have long cited examples that prove that conversion to JIT will reduce space in