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An inventory control problem for deteriorating items with back-ordering and financial considerations

Ata Allah Taleizadeh [a,*], Mohammadreza Nematollahi [b]

[a] School of Industrial and Systems Engineering, College of Engineering, University of Tehran, Tehran, Iran
[b] Department of Industrial Engineering, Iran University of Science and Technology, Tehran, Iran

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ABSTRACT

This paper investigates the effects of time value of money and inflation on the optimal ordering policy in an inventory control system. We proposed an economic order quantity model to manage a perishable item over the finite horizon planning under which back-ordering and delayed payment are assumed. The demand and deterioration rates are constant. The present value of total cost during the planning horizon in this inventory system is modeled first, then a three phases solution procedure is proposed to derive the optimal order and shortage quantities, and the number of replenishment during the planning horizon. Finally, the proposed model is illustrated through numerical examples and the sensitivity analysis is reported to find some managerial insights.

1. Introduction

In real world problem, deterioration of many items such as chemicals, volatile liquids, blood banks, medicines and some other goods during storage period is non-negligible. In general, deterioration is defined as the decay, damage, spoilage, evaporation and obsolescence of stored items and it results in decreasing usefulness [1]. So, the management and holding of inventories of perishable items becomes an important problem for inventory managers. In the other hand, delayed payment is an important form of financing for businesses in a broad range of industries and economies that extremely well-developed and are being used in financial markets. Furthermore, both inflation and time value of money issues will have main effects in financial markets. All of the above mentioned issues (deteriorating items, delayed payment, inflation and time value of money) are separately regarded in some inventory models. But as is shown in Table 1 there are a few researches in which only number of all of the considered topics are mentioned together. Also there is no research in which all of them had been considered. For instance, Ghare and Schrader [22] were the pioneers to establish an inventory model for deteriorating items. Covert and Philip [18] extended Ghare and Schrader's constant deterioration rate to a two-parameter Weibull distribution. In continue this topic was investigated with many researchers. Aggarwal and Jaggi [2] proposed an inventory control model for deteriorating items in which shortage was not permitted. Hariga and Ben-daya [24] developed lot-sizing problem with time-dependent demand under inflationary conditions.

Ray and Chaudhuri [51] developed a finite time-horizon EOQ model with backordering where the varying demand rate whereas the effects of inflation and the time value of money are taken into account. Chen [10] considered situation in which the demand rate is time-proportional and shortages are fully Backordered. He investigated the effects of inflation and time-

* Corresponding author. Tel.: +98 9363447171.
E-mail addresses: Ata.taleizadeh@gmail.com, taleizadeh@ut.ac.ir (A.A. Taleizadeh), mr.nematollahi@yahoo.com (M. Nematollahi).

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Table 1
Brief literature review.

No	Inventory Control System	Shortage	Deterioration	Delayed Payment	Inflation	Time Value of Money	Solution Method
[2]	EOQ		x	x			Non-closed-form
[3]	EPQ	x	x		x	x	Closed-form
[4]	EOQ	x		x	x		Closed-form
[5]	EOQ		x	x			Closed-form
[6]	EOQ	x					Closed form
[7]	EOQ		x	x	x		Closed-form
[8]	EOQ			x			Closed-form
[1]	EOQ		x	x		x	Closed-form
[9]	EOQ		x	x	x		Closed-form
[10]	EOQ	x	x		x	x	Non-closed-form
[11]	EOQ	x	x		x	x	Non-closed-form
[12]	EOQ	x	x		x	x	Non-closed-form
[13]	EOQ			x			Closed-form
[14]	EOQ		x	x			Closed-form
[15]	EOQ	x	x		x	x	Non-closed-form
[16]	EOQ			x		x	Closed-form
[17]	EOQ	x		x			Closed-form
[18]	EOQ			x			Closed-form
[19]	EOQ		x	x			Non-closed-form
[20]	EOQ	x	x		x	x	Non-closed-form
[21]	EOQ	x	x				Non-closed-form
[22]	EOQ			x			Closed-form
[23]	EOQ	x	x				Non-closed-form
[24]	EOQ				x	x	Non-closed-form
[25]	EOQ	x	x		x	x	Non-closed-form
[26]	EOQ	x	x		x	x	Non-closed-form
[27]	EPQ	x		x			Closed-form
[28]	EOQ			x			Closed-form
[29]	EOQ			x			Closed-form
[30]	EPQ			x			Closed-form
[31]	EOQ	x	x				Non-closed-form
[32]	EOQ			x			Closed-form
[33]	EOQ		x	x			Non-closed-form
[34]	EOQ	x	x		x		Non-closed-form
[35]	EOQ			x			Closed-form
[36]	EOQ	x	x		x	x	Closed-form
[37]	EOQ	x	x	x			Non-closed-form
[38]	EOQ			x			Closed-form
[39]	EOQ		x	x			Non-closed-form
[40]	EOQ		x	x	x		Non-closed-form
[41]	EOQ			x	x		Closed-form
[42]	EOQ	x	x		x		Closed-form
[43]	EOQ			x			Non-closed-form
[44]	EOQ	x	x		x	x	Non-closed-form
[45]	EPQ	x	x			x	Non-closed-form
[46]	EOQ			x			Closed-form
[47]	EOQ	x	x		x	x	Non-closed-form
[48]	EOQ		x				Non-closed-form
[49]	EOQ		x	x			Closed-form
[50]	EOQ			x		x	Closed-form
[51]	EOQ	x			x	x	Non-closed-form
[52]	EPQ				x	x	Non-closed-form
[53]	EOQ		x		x	x	Non-closed-form
[54]	EOQ		x		x	x	Non-closed-form
[55]	EOQ			x			Closed-form
[56]	EOQ		x	x			Non-closed-form
[57]	EPQ	x			x	x	Non-closed-form
[58]	EPQ	x			x		Non-closed-form
[59]	EOQ			x			Closed-form
[60]	EPQ			x			Closed-form
[61]	EOQ	x	x		x		Non-closed-form
[62]	EOQ	x	x		x		Non-closed-form
[63]	EOQ	x	x		x	x	Closed-form

value of money too. Chung and Lin [15] developed an EOQ model for deteriorating items taking account of time value of money over a fixed planning horizon. Liao and Chen [41] developed an EOQ model under a situation in which the effects of the inflation, deterioration, initial stock-dependent demand rates and wholesaler's permissible delay in payment are dis-