行政院國家科學委員會補助專題研究計畫成果報告

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※ 有限計畫期間下同時考慮延遲付款條件 ※

※ 及貨幣時間價值的退化性商品存貨模式 ※

※ A Finite Time Horizon Inventory Model with Deterioration ※

※ and Time-value of Money Under the Conditions of ※

※ Permissible Delay in Payments ※

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計畫類別：個別型計畫

計畫編號：NSC－90－2218－E－032－010

執行期間：90 年 8 月 1 日至 91 年 7 月 31 日

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行政院國家科學委員會專題研究計畫成果報告

有限計畫期間下同時考慮延遲付款條件及貨幣時間價值的退化性商品存貨模式

A Finite Time Horizon Inventory Model with Deterioration and Time-value of Money Under the Conditions of Permissible Delay in Payments

計畫編號：NSC－90－2218－E－032－010
執行期限：90 年 8 月 1 日至 91 年 7 月 31 日
主持人：李培齊　　淡江大學管理科學學系
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摘　　要

在傳統的經濟訂購量(EOQ)模式中，通常假設買方於收到訂購品項時立即付款予供應商。此一現象反映在真實的市場交易行為中，部分情境是需要加以修正的，因為供應商往往基於某些經營目的或追求經濟上的最大效益，而提供買方一個延遲付款的信用期限，以刺激需求。在研究中，我們考量在供應商允許延遲付款情況下，同時將變動的退化率及貨幣的時間價值(time value of money)因素加以整合納入傳統的經濟訂購量(EOQ)模式中，目的在於求得最適的補貨次數及服務水準以使得有限計畫期間中的存貨總相關成本淨現值為最小。此外，我們將提出兩個特殊狀況並以數值範例來呈現所建構的模式，並對模式中參數的變化如何影響最佳解(optimal solution)做敏感性分析。

關鍵詞：經濟訂購量、退化性商品、貨幣的時間價值、允許延遲付款

ABSTRACT

In this paper, a varying deterioration rate, time-value of money and the condition of permissible delay in payments used in conjunction with the EOQ model are the focus of discussion. The replenishment number and the fraction of each cycle in which there is no shortage are both determined so as to minimize the present value of inventory cost over a finite planning horizon. Two special cases and numerical examples are presented to illustrate the model.

Keywords：EOQ; deteriorating items;
time-value of money;
permissible delay in payments.

SOURCE AND PURPOSE

In most of the literature dealing with inventory problems, either in deterministic or probabilistic model, it is often assumed that payment will be made to the supplier for the goods immediately after receiving the consignment. However, one can easily observe that a supplier provides a credit period for a retailer to stimulate the demand, boost market share or decrease inventories of certain items. Goyal (1985) first studied an EOQ model under the conditions of permissible delay in payments. Chung (1989) presented the discounted cash-flows approach for the analysis of the optimal inventory policy in the presence of the trade credit. Recently, to accommodate more practical features of the real inventory systems, Aggarwal and Jaggi (1995) and Hwang and Shinn (1996) extended Goyal's model to consider the deterministic inventory

model with a constant deterioration rate. Shan and Shan (1998) developed a probabilistic inventory model when delay in payment is permissible. They developed an EOQ model for deteriorating items in which time and deterioration of units are treated as continuous variable and demand is a random variable. Later, Jamal *et al.* (1997) extended Aggarwal and Jaggi's (1995) model to allow for shortages and makes it more applicable in real world.

Furthermore, since the 1970s energy crisis, many countries experience high annual inflation rates. As a result, while determining the optimal inventory policy, the effects of inflation and time value of money can't be ignored. The fundamental result in the development of EOQ model with inflation is that of Buzacott (1975) who establish EOQ model with inflation subject to different type of pricing policies. Wee and Law (1999) addressed the problem with finite replenishment rate and the items deteriorate follows a Weibull distribution for a finite planning horizon. More recently, Liao et al. (2000) investigated the effects of time-value of money and credit period on an inventory model for an exponentially deteriorating product with initial-stock-dependent demand. Sarker et al. (2000) extended their previous research to consider the effect of time-value of money. However, none of the above models simultaneously considered the time value of money and marketing strategies when permissible delay in payments and shortages are allowed in the finite planning horizon. Hence, the purpose of this study is to propose a finite time horizon EOQ model with a general deterioration rate including the conditions of time value of money and allowable shortage and permissible delay in payments to extend the applications of developing mathematical inventory models and fit a more general inventory feature.

RESULT AND DISCUSSION

The article derives the optimal EOQ replenishment policy for a finite planning horizon under the conditions of shortages and permissible delay in payments. In addition, a time-varying deterioration rate and time-value of money are also taken into the consideration. The analytical formulations of the problem on the general framework described as above have been given. Furthermore, we also provide two special types of deterioration rate to illustrate the proposed models: (i)Weibull deterioration rate and (ii)Exponential deterioration rate. The main reason for choosing Weibull deterioration rate is that the failure and life expectancy of many items can be expressed in items of Weibull distribution from many empirical observations. When the shape parameter of Weibull distribution equals to one, the rate of deterioration becomes a constant in which is the case of an exponential decay. When the shape parameter great than one, the rate of deterioration is increasing with time. This can apply for example to vegetables that experience an increase in their rate of decay due to the rise temperature. Hence, the utilization of a two-parameter Weibull distribution can make the scope of the application broader. Furthermore, the model can be seen as an extension of Jamal *et al.* (1997) by incorporating a time-varying deterioration rate and time-value of money for a finite planning horizon.

SELF-EVALUATION

This research corresponds to the original plan and has attained its aim. Hence, the paper is of great academic value and suitable for publication in academic journals. It is now being accepted by "International Journal of Systems Science".

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