行政院國家科學委員會專題研究計劃成果報告

在實收貨品數量不確定下前置時間與整備成本可縮減之連續盤查存貨模式

Lead time and setup cost reductions in continuous review inventory model when the amount received is uncertain

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摘　　要

在近代生產管理方面，日本企業界提出及時(Just-in-Time, JIT)存貨管理系統以提高企業的生產力，且效果頗為顯著。所謂 JIT 存貨管理系統是強調高品質、低存貨、低整備成本(setup cost)及短的前置時間(lead time)。因此，前置時間與整備成本是可藉由額外投資成本的增加來縮減。縮短前置時間及減少整備成本可以降低安全存量、減少資金積壓、提高對顧客的服務水準、並增加企業的競爭能力。本研究針對此特性(前置時間及整備成本藉由額外投資成本的增加而縮減)嘗試建立在實收貨品數量不確定下，缺貨數量允許部份欠撥與部份不補(銷售損失)的混合存貨模型，其中訂購量、請購點、整備成本及前置時間均為決策變數。在本研究中，我們首先假設前置時間內的需求量服從常態分配，其次探討前置時間內需求量的機率分配為未知的情形，並且利用大中取小分配不拘程序求解。我們亦分別針對此兩種情形(前置時間內需求量的機率分配為常態分配或分配不拘)建立求得最適訂購策略之演算法，且探討參數的敏感度分析。

關鍵詞：前置時間、整備成本、資本投資、大中取小分配不拘程序

ABSTARCT

Through the Japanese experience of using Just-in-Time (JIT) production shows that there are advantages and benefits associated with their efforts to reduce lead time and setup cost. Therefore, lead time and setup cost can be reduced by the expensive of an additional investment cost. By reducing lead time and setup cost, we can lower the safety stock, reduce the loss caused by shortage, improve the service level to the customer, and increase the competitive ability in business. This article combines the concept of capital investment allocated to reduce lead time and setup cost when the amount received is uncertain. Our goal is to focus on this property (lead time and setup cost can be reduced by capital investment cost) and try to develop a mixture inventory model with backorder and lost sale, in which order quantity, reorder point, setup cost and lead time are decision variables. In our studies, we first assume that lead time demand follows a normal distribution, and then consider the case that the form of the distribution function of lead time demand is unknown and apply the minimax distribution free procedure to solve the problem. We also develop an algorithm to obtain the optimal ordering strategy for each case (the lead time demand follows normal distribution or distribution free). Furthermore, the effects of parameters are also included.

Keywords：lead time, setup cost, capital investment, minimax distribution free procedure

SOURCE AND PURPOSE

In most of the literature dealing with inventory problems, either in deterministic or probabilistic model, lead time is viewed as a prescribed constant or a stochastic variable, which therefore, is not subject to control (see, for example, Naddor [12] and Silver and Peterson [31]). In fact, lead time usually consists of the following components: order preparation, order transit, supplier lead time, delivery time, and setup time (Tersine [32]). In many practical situations, lead time can be reduced by an additional investment cost; in other words, it is controllable. By shortening the lead time, we can lower the safety stock, reduce the loss caused by stockout, improve the service level to the customer, and increase the competitive ability in business.

Through the Japanese experience of using JIT production, the advantages and benefits associated with the efforts to control the lead time can be clearly perceived. Lead time has been a topic of interest in inventory system for many authors [e.g., 3,4,10]. Recently, some models considering lead time as a decision variable have been developed. Liao and Shyu [9] have initiated a study on lead-time reduction by presenting an inventory model in which lead-time is a decision variable and the order quantity is predetermined. Ben-Daya and Raouf [1] developed a model that considered both lead-time and order quantity as decision variables. Later, Ouyang et al. [14] and Ouyang and Wu [15,16,26] have generalized the Ben-Daya and Raouf [1] model by considering shortages in which the lead-time demand is considered a normal distribution or distribution free. Later, Moon and Choi [11], Ouyang and Chuang [18-20, 22-25], Ouyang, Chen and Chang [21], Ouyang, Chuang and Wu [27], Wu and Ouyang [34], and Hariga and Ben-Daya [6] have extended the Ouyang et al. [14] model to relax the assumption of a given service level and treat the reorder point as a decision variable under various circumstances. However, all models previously mentioned have assumed that the quantity received is the same as the quantity ordered. The quantity may not match the quantity ordered due to various reasons such as rejection during inspection, damage or breakage during transportation, etc.

On the other hand, there have been investigations into EOQ (EMQ) models consists setup cost reduction in recently. The setup cost usually includes preparing the shop order, scheduling the work, reproduction setup, expediting and quantity acceptance. Hong and Hayya [7] pointed out that the reduced setup costs with the accompanying smaller lot sizes have numerous benefits including (1) reduced manufacturing lead time, (2) improved quality due to the early detection of defects, (3) reduced work in process, (4) easier scheduling and sequencing, (5) increased production capacity, (6) increased operational flexibility, (7) reduced storage space, and (8) lower investment in inventory. Porteus [29] first investigated the impact of capital investment in reducing setup cost on the classical EOQ model. Billington [2] presented an EPQ model with the setup cost parameter replace by a function of capital investment. Several relationships between the amount of capital investment and the setup cost level have been reported by many researchers in Porteus [29], Billington [2], Nori and Sarker [13], Trevino et al. [33], Kim et al. [8], and Sarker and Coates [30].

The logarithmic relationship of setup cost (or lead time) to investment discussed is not only an interesting special case but also a practical one. This logarithmic investment function, which has been used in previous researchers by Paknejad et al. [28], and Sarker and Coates [30], is consistent with the Japanese experience as reported in Hall [5]. Therefore, this article assumes that the relationship between setup cost (or lead time) reduction and capital investment can be described by the logarithmic investment function. The purpose of this article is developing the continuous review inventory model involving order quantity, reorder point, lead time and setup cost reduction investment as decision variables when the amount received is uncertain.

In this article, we first assume that the lead time demand follows a normal distribution, and find the optimal solution. And then we consider any distribution function (d.f.), says F, of the lead time demand has only known finite first and second moments (and hence, mean and variance are also known). In this situation, for convenience, we let $\boldsymbol{F}$ denoted the class of d.f. F's with finite mean DL and variance $\pm^2 L$ (where D is average demand per year; L is the length of the lead time; $\pm^2$ is variance of the demand per unit time). Our goal is to solve a mixed inventory model with defective items by using the minimax distribution free approach. That is, the purpose of this model is to develop an algorithm procedure to find the most unfavorable d.f. in $\boldsymbol{F}$ for each decision variable (A, Q, r, L) and then minimize over the decision variables. Furthermore, the effects of parameters are performed.

RESULT AND DISSCUSSION

This research aims at developing the mathematical inventory model for reducing lead time and setup cost as well as the amount received is uncertain. Its optimal solution is then obtained. To help managers understand the effects of optimal solution on changes in the values of the different parameters associated with the inventory system, sensitivity analysis is also performed in the paper. This research develops a more realistic inventory model, which can enhance the efficiency of an inventory manager in decision-making.

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. Journal of Information & Management Sciences now accept it.

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