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投資在品質改善和前置時間縮減對整合買賣雙方的存貨模式之影響

計畫類別：個別型計畫
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計畫主持人：歐陽良裕

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中文摘要

過去二十年，日本人運用及時生產系統（JIT）的成功經驗，已被廣泛的引起注意。及時生產的主要目標是消除浪費，這可經由各種努力，譬如縮短前置時間和改善品質來達成。本研究，擬探討投資在品質改善和前置時間縮減對整合買賣雙方且允許部分欠撥的存貨模式之影響。首先假設前置時間內的需求量服從常態分配；接著，放寬此假設，考慮分配不拘但其平均數和標準差為已知的情形。我們將建立一個演算法，以幫助得到最適策略。最後，以數值範例來說明求解的過程和結果。

關鍵詞: 整合存貨模式、品質改善、前置時間縮減、部分欠撥、大中取小分配不拘程序

Abstract

In past two decades, the Japanese successful experience of using just-in-time (JIT) production has received a great deal of attention. The underlying goal of JIT is to eliminate waste, which can be achieved through various efforts, such as shortening lead time and improving quality. In this research, we will investigate the impact of investing in quality improvement and lead time reduction on the integrated vendor-buyer inventory model with partial backorders. We first assume that the lead time demand follows a normal distribution, and then relax this assumption to consider the distribution-free case where only the mean and standard deviation of lead time demand are known. An algorithm procedure will be developed to help finding the optimal strategy. Furthermore, numerical examples will be performed to illustrate the results.

Keywords: integrated inventory model, quality improvement, lead time reduction, partial backorders, minimax distribution-free procedure

Source and purpose

In recent times, the Japanese successful experience of using just-in-time (JIT) production triggered considerable attention. The ultimate goal of JIT from the production/inventory management standpoint is to produce small lot sizes with good-quality products. In order to achieve this goal, investing capital in shortening lead time and improving quality are regarded as the effective ways. By shortening lead time, we can lower the safety stock, reduce the stock-out loss and improve the customer service level so as to gain competitive advantages in business. Liao and Shyu [1] first presented a probabilistic inventory model in which the order quantity is predetermined and lead time is the unique decision variable. Ben-Daya and Raouf [2] extended Liao and Shyu's [1] model by considering both lead time and ordering quantity as decision variables where shortages are neglected. Ouyang *et al.* [3] generalized Ben-Daya and Raouf's [2] model by allowing shortages with partial backorders. Moon and Choi [4] and Hariga and Ben-Daya [5] revised Ouyang *et al.* [3] model by including the reorder point as one of the decision variables. These papers [1-5] focused on the benefits of lead-time reduction where the quality-related issues are not taken into account.

In the classical economic order quantity (EOQ) model, it is implicit assumed that quality level is fixed at an optimal level (i.e., all items are assumed with perfect quality) and not controllable. However, this is not quite true. In the real production environment, it can often be observed that there are defective items being produced due to imperfect production processes. The defective items must be rejected, repaired, reworked, or, if they have reached the customer, refunded. In all cases, substantial costs are incurred. Therefore, for the system with imperfect production process, the manager may consider investing capital on quality improvement, so as to reduce the quality-related costs. In the literature, Porteus [6] and Rosenblatt and Lee [7] are among the first who explicitly elaborated on a significant relationship between quality imperfection and lot size. Keller and Noori [8] extended Porteus' [6] work to the situation where the demand during lead time is probabilistic and shortages are allowed. Hwang *et al*. [9] studied the multiproduct economic lot size models in which setup reduction and quality improvement can be achieved with one-time initial investment. Hayya and Hong [10] presented a model including a budget constraint and other types of continuous functions for quality enhancement and setup cost reduction. Ouyang and Chang [11] investigated the impact of quality improvement on the modified lot size reorder point models involving variable lead time and partial backorders. Ouyang *et al*. [12] extended Ouyang and Chang's [11] model by investing in process quality improvement and setup cost reduction simultaneously. Recently, Tripathy *et al*. [13] presented an EOQ model with imperfect production process and the unit production cost is directly related to process reliability and inversely related to the demand rate. The relative models [6-13] tackled quality improvement focused on classical EPQ model. These models neglect the opportunity that buyer and vendor can cooperate together to obtain a better joint policy.

The concept of integrated vendor-buyer inventory management has received a great deal of attention, accompanying the growth of Supply Chain Management (SCM). Researches on the integrated vendor-buyer cooperative inventory problem most focused on the order quantity, the number of deliveries, and shipping quantity under perfect quality (see, e.g. Lu [14], Goyal [15], Hill [16, 17], Goyal and Nebebe [18], and Kelle *et al*. [19]). The above mentioned literatures do not describe the possible relationship between production batch and quality. However, in reality, we often observe that defective items being produced due to imperfect production processes.

In this research, we intend to present a paradigm of vendor-buyer integrated inventory model with quality-related issues. We assume that the production process employed to vendor products is imperfect and can be improved by extra capital investment. Also, the vendor will deliver the order quantity to buyer in several equal sized shipments. Inventory is continuously reviewed, and buyer will request successive shipment whenever the on hand inventory level falls to the reorder point. Consequently, we consider an integrated inventory model involving variable lead time with partial backorders in which the order quantity, reorder point, process quality level, lead time and number of shipment from vendor to buyer are decision variables. The model is developed with full and partial information about the lead time demand distribution. We first assume that the lead time demand follows a normal distribution, and find the optimal integrated policy. Next, we relax this assumption and merely assume that the first and second moments of the probability distribution of lead time demand are known and finite, and then solve this inventory model by using the minimax distribution-free approach. Furthermore, numerical examples are provided to illustrate the results and the effects of parameters.

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Self-evaluation

This research corresponds to the original plan and has attained its aim. Hence, the study is of great academic value and suitable for publication in academic journals. It is now being submitted to International Journal of Production Economics (for the case when lead time demand follows normal distribution) and Asia-Pacific Journal of Operational Research (for the case when lead time demand is distribution-free).