行政院國家科學委員會專題研究計劃成果報告

含有服務水準限制式的(Q,R,L)存貨模型之大中取小分配自由程序

A Minimax Distribution Free Procedure for (Q,R,L) Inventory Model subject to a Service Level Constraint

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摘　　要

本研究假設到達的訂購批量中含有部份瑕疵品[redacted]隨[redacted]我們提出一個連續檢查的部份欠撥與部份不補(即[redacted]貨[redacted]型中訂購數量、請購點及前置時間均為決策變數。[redacted]含[redacted]本項，代之以服務水準的限制式；並且前置時間內需[redacted]考慮[redacted]的情形，而僅假設其平均數及變異數存在且已知。我[redacted]以找[redacted]的訂購策略。進一步，我們探討了敏感性分析。

關鍵詞：存貨　瑕疵品、服務水準　趕工成本　大中[redacted]程序

ABSTRACT

This study assumes that an arrival order lot may conta[redacted]efective ite[redacted] and the defective rate is a random variable. We present a con[redacted]view invento[redacted] model with a mixture of backorders and lost sales in which th[redacted]quantity, reord[redacted] point, and lead time are viewed as the decision variables. Inste[redacted]ving a stockou[redacted] cost term in the objective function, a service level constraint is[redacted]to the model. I[redacted] this research, we consider the case that the form of the probabil[redacted]stribution of lead time demand is unknown, and only assume that the mean and [redacted]nce of lead time demand are known. We develop a procedure to determine t[redacted]optimal ordering strategy. Furthermore, the sensitivity analysis is also studied.

Keywords: inventory, defective item, service level, crashing cost, minimax distribution free procedure

SOURCE AND PURPOSE

In traditional continuous review (Q, R) inventory models, lead time is viewed as a prescribed constant or a stochastic variable, which therefore, is not subject to control (see, for example, Naddor [6], Silver and Peterson [9]). In fact, lead time usually consists of the following components (Tersine [10]): order preparation, order transit, supplier lead time, delivery time and setup time. In many practical situations, lead time can be reduced at an added crashing cost; in other words, it is controllable. By shortening the lead time, we can lower the safety stock, reduce the stockout loss, improve the customer service level so as to gain the competitive advantages in business. Through the Japanese experience of using Just-In-Time (JIT) production, the advantages and benefits associated with efforts to control the lead time can be clearly perceived.

Recently, some inventory model literature considering lead time as a decision variable have been developed. Liao and Shyu [4] first presented a probabilistic inventory model in which the order quantity was predetermined and lead time was a unique variable. Ben-Daya and Raouf [2] extended Liao and Shyu's [4] model by considering both the lead time and order quantity as decision variables where shortages were neglected. Ouyang *et al*. [7] generalized Ben-Daya and Raouf's [2] model by allowing shortages. In a recent article, Ouyang and Wu [8] considered an inventory model with a mixture of backorders and lost sales, and applied the minimax decision rule to solve the distribution free model. However, in above models [2,7,8], the reorder point was not taken into consideration, and merely focused on the relationship between lead time and order quantity; that is, they neglected the possible impact of the reorder point on the economic ordering strategy. In this article, we attempt to allow the reorder point as one of the decision variables in the modeling.

On the other hand, the above body of literature does not describe the possible relationship between order lot and quality. For practical inventory systems, defective items in an arrival order lot are unavoidable due to various uncertainties. In general, they involve imperfect production of the supplier, and/or damage in transit. If there are defective items in orders, these will impact on the on-hand inventory level, the number of shortages and frequency of orders in the inventory system. Therefore, ordering policies determined by conventional models may be inappropriate for the situation that an arrival lot contains some defective items.

Moreover, in many practices, the stockout cost includes intangible components such as loss of goodwill and potential delay to the other parts of the inventory system, and hence it is difficult to determine an exact value for the stockout cost. Hence, many authors replace the stockout cost by a condition on the service level (see, for example, Aardal *et al*. [1] and Moon and Choi [5]).

In this article, we assume that an arrival order lot may contain some defective items and the defective rate is a random variable. The purpose of this paper is to extend Ouyang and Wu's [8] model to fit a more realistic situation. That is, our goal is to establish a (Q, R, L) inventory model which contains some defective items in an arrival order lot, and to develop an algorithm for the optimal ordering strategy subject to a service level constraint. We consider the case that the form of the probability distribution of lead time demand is unknown, and merely assume that the first and second moments of the probability density function (*p.d.f.*), say f_X, of lead time demand are known and finite (and hence, mean and variance are also known and finite). In this situation, for convenience, we let denote the class of *p.d.f.* f_X's with finite mean and variance. And then solve this inventory model by using the minimax distribution free approach. Further, the sensitivity analysis is included and a numerical example is given.

RESULT AND DISSCUSSION

This research aims at developing the mathematical inventory model where the order lot contains defective items, and order quantity, reorder point and lead time are simultaneously considered as decision variables. Under the situation that the form of probability distribution of the lead time demand is unknown, the optimal solution is obtained by using the minimax distribution free approach. 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 study 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. It is now being accepted by Journal of Interdisciplinary Mathematics.

REFERENCES

1. Aardal, K., Jonssön, Ö. and Jonsson, H. (1989), Optimal Inventory Policies with Service-level Constraints. *Journal of the Operational Research Society*, Vol. 40, pp. 65-73.
2. Ben-Daya, M. and Raouf, A. (1994), Inventory Models Involving Lead Time as Decision Variable, *Journal of the Operational Research Society*, Vol. 45, pp.

579-582.

3. Gallego, G. and Moon, I. (1993), The Distribution Free Newsboy Problem : Review and Extensions, *Journal of the Operational Research Society*, Vol. 44, pp. 825-834.
4. Liao, C. J. and Shyu, C. H. (1991), An Analytical Determination of Lead Time with Normal Demand, *International Journal of Operations & Production Management*, Vol. 11, pp. 72-78.
5. Moon, I. and Choi, S. (1994), The Distribution Free Continuous Review Inventory System with a Service Level Constraint. *Computers & Industrial Engineering.*, Vol. 27, pp. 209-212.
6. Naddor, E. (1966), *Inventory System*, John Wiley and Sons, New York.
7. Ouyang, L. Y., Yeh, N. C. and Wu, K. S. (1996), Mixture Inventory Model with Backorders and Lost Sales for Variable Lead Time, *Journal of the Operational Research Society*, Vol. 47, pp. 829-832.
8. Ouyang, L. Y. and Wu, K. S. (1998), A Minimax Distribution Free Procedure for Mixture Inventory Model Involving Variable Lead Time, *International Journal of Production Economics*, Vol. 56-57, pp. 511-516.
9. Silver, E. A. and Peterson, R. (1985), *Decision Systems for Inventory Management and Production Planning*, John Wiley, New York.
10. Tersine, R. J. (1982), *Principles of Inventory and Materials Management*, North Holland, New York.