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A Note on Impact of Investing in Quality Improvement on the Lot Size Model

1. INTRODUCTION

RECENTLY KELLER AND NOORI [1] studied a model for investing in quality improvement on the lot size model. They extended Porteus' [2] work to the case where demand during the lead time is probabilistic. They obtained explicit solutions for two specific demand distributions using a logarithmic investment function. However, we can show that there is a mistake in their solution procedure, and consequently, we need some properties of the cost function and the optimal solution similar to those in Porteus [2].

2. CORRECTION

Keller and Noori [1] claimed that $W(q)$ is convex in q, and found a value q' s.t. $dW/dq = 0$. However, we can easily show that $W(q) = K(q) + iV(q)$ is not convex in q as follows. (We consider the uniform demand during lead time. Similar analysis can be done for exponential demand during lead time.)

By differentiating $K(q)$ twice, we get

$$\frac{d^2K(q)}{dq^2} = -\lambda^4 C^2 S^2 [2\lambda S[h(1-\alpha) + \lambda Cq]]^{-3/2} < 0,$$

consequently, $K(q)$ is strictly concave in q. Since $V(q)$ is convex in q, $W(q)$ is the sum of a concave and a convex function.

Consequently, q' does not guarantee an optimal solution of W. Thus, we need to prove that W has a unique local minimum on $[0,q_0]$, which is similar to the proposition in Porteus [2]. Fortunately, we can prove the existence of a unique local minimum by employing the technique used in Porteus [2].

In summary, Keller and Noori [1] developed a procedure to find an optimal solution asserting that the cost function is convex in q. However, we showed that the cost function is not convex in q. Consequently, we needed a proposition which shows the existence of a unique local minimum. We can prove that there exists a unique local minimum for the cost function by employing similar technique as in Porteus [2], therefore showed that the procedure developed by Keller and Noori [1] can be still valid.

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