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A production model for deteriorating items with stochastic preventive maintenance time and rework process with FIFO rule

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ABSTRACT

Due to unreliable production facility and stochastic preventive maintenance, deriving an optimal production inventory decision in practice is very complicated. In this paper, we develop a production model for deteriorating items with stochastic preventive maintenance time and rework using the first in first out (FIFO) rule. From our literature search, no study has been done on the above problem. The problem is solved using a simple search procedure; this makes it more practical for use by industries. Two case examples using uniform and exponential distribution preventive maintenance time are applied. Examples and sensitivity analysis are conducted for each case. The results show that rework and preventive maintenance time have significant affected the total cost and the optimal production time. This provides helpful managerial insights to help management in making smart decisions.

1. Introduction

Due to rapid globalization in the last decade, many manufacturers face tight competition in the market place. Nowadays, consumers know where to find goods with cheaper price, better quality and faster delivery. Rework is a popular strategy by many companies to reduce their production cost and to maintain high product quality. From our literature search, no research has considered simultaneously the deteriorating inventory, stochastic preventive time (due to unforeseen circumstances such as finding the unplanned parts that need to be replaced), lost sales possibility and the first in first out (FIFO) rule. In real-life, most manufacturers try to reduce lost sales due to shortage. However, due to the stochastic nature of the model, shortages may occur. By considering lost sales cost in our modeling, we penalize the undesired effect of shortage. By optimizing the model, we seek to find the tradeoff between too much or too little inventory. Shortage should be kept as low as possible especially if the shortage cost is high. However, if the shortage cost is so large that it approaches infinity (for example, shortage of blood for emergency transfusion will result in human death, a very high cost indeed!), then blood in hospital should never be running out. The condition is also application for critical parts in industry where the shortage is extremely costly. Due to the characteristic of our model, it will optimize to no shortage model when shortage cost is very high. Therefore, considering lost sale during shortage gives us wider options in our replenishment decisions, thus a more general solution.

Schrady [1] was one of the earliest researchers in production models who considered rework processes. Chung and Hou [2] considered imperfect process, rework and shortages in their EPQ model. Teunter [3] developed an optimal production and rework lot-size quantity models for two lot sizing policies. Recently, Widyadana and Wee [4] simplified the solution methods by introducing an algebraic approach. Buscher and Lindner [5] developed an EPQ model which addresses lot size of production, rework and shipment. Chiu et al. [6] developed EPQ models which addressed random breakdown of production machines and rework. A similar model considering service level constraints with rework was developed by Chiu et al. [7]. Liu et al. [8] analyzed the number of production and rework setups used in one cycle; as well as their sequence and optimal production quantity in each setup. Cardenas-Barron [9] developed an EPQ model with rework by using a planned backorder. Sana [10] proposed an extended production inventory model with rework by considering variable product reliability factors, variable unit production costs and a dynamic production rate. The effect of scrap, rework and stochastic machine breakdown under an abort/resume (AR) policy was considered by Chiu [11]. Similar research has been conducted by Chiu et al. [12]. However none of the above research considered deteriorating items in their models.

Deteriorating items are items that lose their utility with time due to decay, damage or spoilage. Some examples of deteriorating items are found in semiconductor, pharmaceutical, chemical and foods. The rework process is commonly applied to products that have a

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