An economic production quantity model for deteriorating items with preventive maintenance policy and random machine breakdown

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In recent years, many researches on economic production quantity (EPQ) models with machine breakdown and preventive maintenance have been developed, but few of them have developed integrated models for deteriorating items. In this study, we develop EPQ models for deteriorating items with preventive maintenance, random machine breakdown and immediate corrective action. Corrective and preventive maintenance times are assumed to be stochastic and the unfulfilled demands are lost sales. Two EPQ models of uniform distribution and exponential distribution of corrective and maintenance times are developed. An example and sensitivity analysis is given to illustrate the models. For the exponental distribution model, it is shown that the corrective time parameter is one of the most sensitive parameters to the optimal total cost.

Keywords: inventory; machine breakdown; deteriorating items; stochastic; corrective and preventive maintenance

1. Introduction

Inventory cost control is one of the most important factors for competitiveness in global supply chains. The application of the economic production quantity (EPQ) model will reduce the inventory and the production costs. Many researchers have done considerable researches in this area. The effects of machine breakdown and corrective maintenance were studied by Groenevelt, Pintelon, and Seidman (1992). Abboud (1997) developed a simple approximation to solve an economic manufacturing quantity (EMQ) problem with machine breakdown. Kim and Hong (1997) extended the EMQ model for a failure prone machine with general life time distribution. Mini and Murthy (2000) analysed two types of repair when the production system breakdown. Abboud (2001) introduced an efficient algorithm using discrete approach and Markov chain theory. He assumed the production inventory system had random machine falures, random corrective times and backordered shortages. Aghezzaf, Jamali, and Ait-Kadi (2007) developed an integrated production and maintenance planning model. They assumed the system had a set of random failure items throughout a finite planning horizon. EPQ models with and without machine breakdown and defective items were developed by Chiu, Wang, and Chiu (2007). A portion of the defective items was assumed repairable and the other was scraped. Chiu, Wang, Ting, Chuang, and Lien (2008) developed an EMQ model with random machine breakdown with constant repair times and shortage backorders. Besides EPQ model, inventory cost in supply chain can be reduced using just in time (JIT) concept (Widyadana, Wee, and Chang 2010).

Since machine breakdown is costly due to shortage, it is more economical for an enterprise to implement preventive maintenance. Meller and Kim (1996) developed a two machine serial production system production inventory model with preventive maintenance. An economic lot sizing model considering machine unavailability and shortage was developed by Abboud, Jaber, and Noueihed (2000). They assumed machine unavailability due to preventive maintenance. The model was extended by Chung, Widyadana, and Wee (2011) who developed an EPQ model for deteriorating items with stochastic machine unavailable time with shortage. Sheu and Chen (2004) developed an EPQ model with imperfect maintenance for an imperfect production process, and recently Wang, Lin, Chen, and Chen (2009) extended the model by considering inspection time length. Giri and Doha (2005) developed EMQ models where the corrective and preventive maintenance times follow a general distribution, and machine capacity can be determined before

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