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A two-echelon inventory model for a deteriorating item with stock-dependent demand, partial backlogging and capacity constraints

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Abstract

This study investigates a two-echelon supply chain model for deteriorating inventory in which the retailer's warehouse has a limited capacity. The system includes one wholesaler and one retailer and aims to minimise the total cost. The demand rate in retailer is stock-dependent and in case of any shortages, the demand is partially backlogged. The warehouse capacity in the retailer (OW) is limited; therefore the retailer can rent a warehouse (RW) if needed with a higher cost compared to OW. The optimisation is done from both the wholesaler's and retailer's perspectives simultaneously. In order to solve the problem a genetic algorithm is devised. After developing a heuristic a numerical example together with sensitivity analysis are presented. Finally, some recommendations for future research are presented.

Keyword: Deteriorating inventory; Two-warehouse model; Stock-dependent demand; Two-echelon supply chain

1. Introduction

In the classical inventory model for deteriorating products it is usually assumed that the warehouse has no limits in the capacity. However, in the real-life problem the situation is different. There are a number of factors which influence the optimum solution in different ways. Sometimes these factors may suggest retailers to buy more than their own warehouse (OW) capacity. In these situations, the retailers can benefit from a rented warehouse (RW).

Another assumption that can greatly influence the optimal policies is to take a supply chain perspective when analysing inventory models. In multi-echelon inventory models, actors try to integrate their businesses in order to improve the overall performance of the system (e. g. by increasing service level, profit of decreasing the cost). Implementing such integrated models however remains challenging especially when the actors are independent businesses and should collaborate very closely (see Fawcett and Magnan, 2002; Power, 2005). In such cases apart from close collaboration between players in the supply chain, there should be a fair mechanism to distribute the incentives between the actors to encourage the integration. Prajogo and Olhager (2012) argue that establishing any mechanisms for supply chain integration is only possible if there is a long-term relationship between the supply chain partners.

To date, very few studies on deteriorating inventory in two-echelon systems have been carried out (see Nahmias, 1982; Raafat, 1991; Goyal and Giri, 2001; Li *et al.*, 2010; Bakker *et al.*, 2012). Considering the general product and deteriorating items, it can be said that deteriorating product literature is still in

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