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A FUZZY BACKORDER INVENTORY MODEL AND APPLICATION TO DETERMINING THE OPTIMAL EMPTY-CONTAINER QUANTITY AT A PORT

Chien-Chang Chou

Department of Shipping Technology
National Kaohsiung Marine University
482, Chung Chou 3rd Rd. Chi Chin, Kaohsiung 805, Taiwan
chiench1@ms58.hinet.net

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Abstract. *This paper proposes a fuzzy backorder inventory model for solving the optimal order quantity inventory problem. In this model, costs and quantities are expressed in trapezoidal fuzzy numbers. This paper uses the Function Principle to manipulate arithmetical operations, the Graded Mean Integration Representation method to defuzzify, and the Kuhn-Tucker conditions to find the optimal backorder quantity and shortage quantity for the fuzzy backorder quantity inventory model. Finally, the utilization of the proposed fuzzy backorder quantity inventory model is demonstrated with a numerical example of empty-container inventory quantity at a port.*

Keywords: Inventory model, Backorder quantity, Fuzzy sets, Function principle, Graded mean integration representation, Kuhn-Tucker conditions

1. **Introduction.** In practice, demand quantities, inventory costs and order costs are not usually crisp values or real numbers. It is more appropriate that demand quantities, inventory costs and order costs are expressed in fuzzy numbers due to the existing uncertainty and vagueness. Thus this paper proposes a fuzzy backorder inventory model for solving the optimal backorder quantity inventory problem.

In the past, several researchers have applied the fuzzy sets theory to deal with the inventory problems. Park [15] used the Extension Principle to solve the inventory problems with fuzzy inventory costs. Chen *et al.* [6] proposed a fuzzy inventory model with fuzzy yearly demands, fuzzy ordering costs, fuzzy inventory costs and fuzzy backorder costs. They used the Function Principle [2] to deal with the fuzzy arithmetical operation on fuzzy numbers, and then used the median rule to obtain the optimal backorder quantity for the fuzzy backorder inventory model. Yao and Lee [19] developed a fuzzy backorder inventory model. They applied the Extension Principle to find the optimal backorder quantity. Chang [1] discussed how to obtain the economic order quantity when the quantity of demand is uncertain. Chen and Hsieh [4] discussed a fuzzy backorder inventory model. The Second Function Principle [3] is applied to the fuzzy arithmetical operations on generalized trapezoidal fuzzy numbers. Chen *et al.* [5] proposed a fuzzy economic production quantity model with fuzzy costs, fuzzy quantities and imperfect production. They used the Function Principle, the Graded Mean Integration Representation method, and the Kuhn-Tucker conditions to obtain the optimal fuzzy economic production quantity. Su [16] studied the fuzzy total demand quantity in an inventory model without backorder. It is very difficult to determine a fixed value $r(o)$. Hence, the paper treats the total demand as an interval-valued fuzzy set centred around an expected value of $r(o)$. The paper derives a correspondingly fuzzy estimate of total cost and develops some conditions for its