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ORIGINAL ARTICLE

A novel fuzzy stochastic multi-objective linear programming for multi-level capacitated lot-sizing problem: a real case study of a furniture company

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Abstract This paper develops a fuzzy stochastic multi-objective linear programming model for a multi-level, capacitated lot-sizing problem (ML-CLSP) in a mixed assembly shop. The proposed model aims to minimize the total cost consisting of total variable production cost, inventory cost, backorder cost, and setup cost while maximizing the resource utilization rate simultaneously. To cope with inherent mixed fuzzy stochastic uncertainty associated with input data, e.g., the demand and process-related parameters, they are treated as fuzzy stochastic parameters. We conducted a numerical example from literature to illustrate the efficiency of the proposed method against other ones. To validate the expediency of the proposed ML-CLSP and solution method, a real case study was executed in a furniture company. The results demonstrate the usefulness of the proposed model and its solution approach.

Keywords Fuzzy stochastic multi-objective programming · Multi-level capacitated lot-sizing problem · Mixed assembly shop · Production planning

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1 Introduction

Based on characteristics of the proposed model and solution method, the objectives of this paper and the most relevant literature is reviewed in two different but related streams: multi-level, capacitated lot-sizing problem (ML-CLSP) and fuzzy stochastic (random) programming.

1.1 ML-CLSP model

The ML-CLSP is a well-known formulation for big-bucket multiple-period, multiple-item lot-sizing problems in capacitated production systems often faced in a practical production planning setting. Setup times/costs occur in such a system when changing from one item to another one. The objective is to find an optimal production plan consisting of the required setup periods and the time-phased production and inventory quantities at each level of a complex bill-of-material (BOM) structure over a finite planning horizon while minimizing the total cost and ultimately meeting all customer demands by the end of concerned horizon (see [1–3]).

There are considerable amounts of works in the context of ML-CLSP. Among them, [4] recalled two formulation of ML-CLSP in the literature with setup times and lost sales. They applied a Lagrangian relaxation of the capacity constraints and a non-myopic heuristic-based approach to find feasible solutions. [5] developed a general solution method combining an ant-based algorithm with an exact solver for multi-level capacitated lot-sizing and scheduling problems.[6] presented two mathematical models for CLSP with lead time considerations which address two cases of batching and lot streaming. [7] proposed a linear mixed integer mathematical programming for multi-product capacitated lot-sizing and scheduling problem in a flow shop environment. Sequence-dependent

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