Newsboy Problem under Some Uncertain Paradigms

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ABSTRACT

The single period inventory model (SPIM) is also known as the newsboy or newsvendor (NV) problem plays a key role in some real life inventory systems for perishable goods, fashion and sports items, auxiliary parts and seasonal products. The classical newsboy problem is formulated to find the optimal order quantity that minimizes the expected cost or maximizes the expected profit. It was introduced by Whitin in the year 1955. From then to date, this notion has been developed in various directions as the characteristic of SPIM is complicated due to complex market situations and its volatility caused by several factors like customers' uncertain behavior, natural disasters, and uncertain demand information. However, the uncertainty appears due to insufficient data, lack of evidence, imperfect statistical analysis, and unauthorized sources in the decision parameters of a problem. This unpredictable demand is generally regarded either as a constant by guessing the lower and upper bounds or as a random variable with some distribution function, and its probability mass/density function may be estimated by statistical and historical data or by fuzzy membership functions.

Due to the increasing difficulties and challenging issues in solving the newsboy problem under uncertainty, managers seek newer and more appropriate approaches to apprehend the demand more accurately for perishable products or products having a short shelf life. Many authors have studied SPIM by considering the demand as a normal random variable with fixed mean and variance. But for more practical situations, the mean demand also varies, yielding two folded randomness in demand distribution. Thus, it becomes more difficult for DMs to apprehend the actual demand having two folded random/birandom distribution. A blend of the birandom theory has been employed to develop the birandom newsboy model (BNM) in our research and find out the optimal order quantity as well as maximize the expected profit. In this study, we also extend the distribution free newsboy problem to the case where the demand is a fuzzy random variable. We analyse the distribution free model in which the mean and variance of the demand are known and the associated probability distribution is unknown. The problem is formulated to find the simple closed-form solution of the optimal order quantity for the distribution free newsboy model with fuzzy-random demand and also compared with existing research work where the product demand is considered as a random variable. Also, our study investigates a newsboy problem with fuzzy random demand in a single product business scenario. To solve the proposed model, a new solution approach

based on chance constraint programming is proposed to formulate the crisp equivalent form of the fuzzy random newsboy problem.

This study also introduces the multiobjective newsboy problem, certainly with the profit maximization objective, while we consider another objective as to minimize the carbon emission. Due to the demand volatility, we study the random fuzzy demand and develop a theorem based on the expected value model to make a crisp equivalent model from the random fuzzy model. Multiobjective particle swarm optimization (MOPSO) algorithm and Non-dominated sorting algorithm -II (NSGA-II) are used to solve the proposed multiobjective model and showed that MOPSO has better performance. For both of the previously mentioned models, we present numerical examples and a real case study to validate the proposed model. The graphical representation of the results of our proposed models may become useful for the decision makers to put an order as their requirements.

Keywords: Newsboy problem, Birandom, Fuzzy random, Random fuzzy, Distribution free, Uncertain variable, Multiobjective optimization, Evolutionary algorithms.