Solving Solid Transportation Problem with Multi-Choice Cost and Stochastic Supply and Demand

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ABSTRACT

This paper proposes a new approach to analyze the solid transportation problem (STP). This new approach considers the multi-choice programming into the cost coefficients of objective function and stochastic programming which is incorporated in three constraints namely sources, destinations and capacities constraints followed by Cauchy’s distribution for solid transportation problem. The multi-choice programming and stochastic programming are combined into solid transportation problem and this new problem is called multi-choice stochastic solid transportation problem (MCSSTP). The solution concepts behind the MCSSTP are based on a new transformation technique which will select an appropriate choice from a set of multi-choice which optimizes the objective function. The stochastic constraints of STP convert into deterministic constraints by stochastic programming approach. Finally, the authors have constructed a non-linear programming problem for MCSSTP and have derived an optimal solution of the specified problem. A realistic example on STP is considered to illustrate the methodology.

Keywords: Cauchy’s Distribution, Multi-Choice Programming, Solid Transportation Problem, Stochastic Programming, Transformation Technique

INTRODUCTION

The classical transportation problem (TP) can be described as a special case of linear programming problem. Its model is applied to determine an optimal solution of the TP of how many units of commodity to be shipped from each origin to various destinations, satisfying source availability and destination demand and minimizing the total cost of transportation. The amounts of available goods at the supply points and the amounts required at the demand points are the parameters of the TP, and these parameters are not always exactly known and stable.
This imprecision may follow from the lack of exact information. The STP is an important extension of the traditional TP. The traditional TP is a well known optimization problem in operations research, in which two kinds of constraints are taken into consideration, i.e., source constraints and destination constraints. But in the real system, we always deal with other constraints besides of source constraints and destination constraints, such as product type constraints or transportation mode constraints. For such case, the traditional TP turns into STP. The STP is a generalization of the well-known TP in which three items (they are source, destination and conveyance) are taken into account in the constraint set instead of two (source and destination). In many industrial problems, a homogeneous product is delivered from an origin to destination by means of different modes of transport called conveyances, such as trucks, cargo flights, goods trains, ships, etc. In reality, due to changes in market supply and demand, weather conditions, road conditions and other unpredictable factors, the STP is important for both theoretical and practical significance.

Stochastic programming deals with situations where some or all of the parameters of the optimization problem are described by random variables rather than by deterministic quantity. The random variables are defined as sources, destinations and conveyances which are depending on the nature and the type of problem. Decision making problems of stochastic optimization arise when certain coefficients of the optimization model are not fixed or known. In such cases, the quantities are random. In recent years, methods of multi-objective stochastic optimization have become increasingly important in the field of economics, industry, transportation, military purpose and technology. The Cauchy’s distribution is a good example of a continuous stable distribution and this distribution is a source of counter examples, having little connection with statistical practice. The Cauchy’s distribution is an old and very important problem in the statistical literature. Particularly, in the recent years it has gained more importance. The Cauchy’s distribution is empirical as many large data sets exhibit on heavy tails and skewness. The strong empirical evidence for these features combined with the generalized central limit theorem is used for many types of physical and economic systems.

In the recent past normal, log-normal, extreme value distribution and other random variables have been considered in the stochastic programming model. Cauchy’s distribution has also two parameters namely location parameter ($\hat{a}$) and scale parameter ($\hat{b}$). It has some similarities with normal distribution. Assuming Cauchy’s distribution is a suitable one for stochastic programming model, we consider the source, the availability and the conveyance parameters of the transportation problem as Cauchy’s distribution. Here, we consider the probability density function of Cauchy’s distribution with location parameter $\hat{a}$ and scale parameter $\hat{b}$ as:

\[
    f(x) = \frac{\hat{a}}{\pi \hat{b}^2 + (x - \hat{a})^2}
\]

\[
    -\infty \left\{ x \left( \infty \text{ and } \hat{a} \right) \text{0 and } \hat{b} \right\} 0 \quad (1)
\]

An extension of the traditional TP to the STP was stated by Shell (Shell, 1955; Haley, 1962) introduced the solution procedure of STP, which is an extension of the modified distribution method. For finding an optimal solution, the STP requires $(m+n+s-2)$ non-zero values of the decision variables to start with a basic feasible solution. (Bit, 1993) developed the fuzzy programming model for multi-objective STP. Patel and Tripathy (1989) presented a computationally superior method for a STP with mixed constraints (Jimenez, & Verdegay, 1998). obtained a solution procedure for uncertain STP. (Hitchcock, 1941) first considered the problem of minimizing the cost of distribution of products from several factories to a number.
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