Chapter 2

Fixed Charged Solid Transportation Problem
With Budget Constraints in
Type–2 Fuzzy Variables:
Multi–Objective Solid Transportation Problem

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ABSTRACT

A multi-objective fixed charged solid transportation model with criterion e.g. transportation penalty, amounts, demands, carriages and budget constraints as type-2 triangular fuzzy variables with condition on few components and carriages is proposed here. With the critical value based reductions of corresponding type-2 fuzzy variables, a nearest interval approximation model and a chance constrained programming model applying generalized credibility measure for the constraints is proposed for this particular problem. The credibility measure is also applied to the objective functions of the chance constrained programming model. The model is then transformed into the corresponding crisp deterministic form by these two methods. A numerical example is provided to explain the model with hypothetical data and is then worked out by applying a gradient based optimization - Generalized Reduced Gradient technique (applying LINGO 16). The corresponding objective function values are compared numerically by two approaches after transforming it to crisp form by these two methods.

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1. INTRODUCTION

In today’s highly competitive market, the pressure on organizations to find better ways to create and deliver value to customers becomes stronger. How and when to send the products to the customers in the quantities in a cost effective manner becomes more challenging. Transportation models provide a powerful framework to meet this challenge. They ensure the efficient movement and timely availability of raw materials and finished goods. The transportation problem (TP) is a special class of linear programming problem in which the objective is to transport a commodity from various plants called origins to different places called destinations at a minimum cost. There are two types of constraints in classical TP namely origin and destination constraints introduced by Balinski (1961). In practical applications, there exists another constraint such as carriage mode constraint besides origin and destination constraints. That is why, the classical transportation problem takes the form solid transportation problem (STP), an exclusive form of linear programming problem, where we deal with condition of sources, destinations and carriages. There may be several other types of constraints besides source, destination and conveyance. It may be budget constraints arising out of limited budget. A few important criterions in the STP are always treated as uncertain variables to fit the realistic positions due to complex situation during the transportation movement. It is impossible to form a transportation plan for the future months because there is no definite data for the amount of quantity necessary at every origin, the requirement at every destination and the carriage quantity and these values all are uncertain. And as such it is much better to explore this issue by applying fuzzy or stochastic optimization models. It is difficult to predict the exact transportation cost for a certain time period. Soft computing is the method to handle uncertainty, partial truth, and approximation to attain practicability, robustness and low solution cost. The principal component of Soft Computing includes Neural Network (NN), Fuzzy Logic (FL), and Genetic Algorithms (GA). Fuzzy set theory is the one of the popular approaches to deal with this uncertainty. Transportation model is sometimes associated with additional costs along with shipping cost that may arise due to toll charges, road taxes etc. In this case it is called fixed charged transportation problem (FCTP).

Multi-item STP is a problem of shipping multiple items from multiple sources to multiple destinations through some conveyance. A situation may arise while transporting some items from origin to some destination where all types of items cannot be transported through all types of conveyances due to nature of items (e.g. liquid, solid, breakable etc.). Multi-item fixed charge solid transportation problem (FCSTP) with restriction on conveyances is a problem of transporting goods to some destinations through a particular conveyance with additional fixed charge for that particular route. The models that are used to find optimal solutions of multiple objective functions of shipping multiple components from multiple sources to multiple destinations over a few carriages are called as multi-item multi-objective solid transportation problem. The authors wish to solve multi-objective multi-item fixed charged solid transportation problem with budget constraints in type-2 fuzzy variables in this chapter.

This chapter has 6 Sections: background is given in Section 2, Section 2.2 contains some basic preliminaries relating to the notions of reductions of type-2 fuzzy variables. Also, CV-based reduction methods for type-2 fuzzy variables are discussed in this Section. Section 3 describes the main focus of the chapter. The authors have formulated a multi-item multi objective fixed charged solid transportation problem with budget constraints and conditions on a few brands and carriages in the sense that a few specific brands are restricted to be shipped over a few particular carriages in Section 3.1. The problem follows some transportation guidelines e.g. unit transportation penalty, fixed costs, amounts, requirements, budget amount and carriage quantities as type-2 triangular fuzzy variables. The model is investigated