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Application of z-restriction-based multi-criteria choice to a marketing mix problem

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Abstract

In this paper the method of solving Z-number valued multiobjective linear programming problem proposed in “R.A. Aliev, O.H. Huseynov, R.R. Aliyev, A.V. Alizadeh, The Arithmetic of Z-numbers. Theory and Applications. Singapore: World Scientific, 2015” is applied to solve a marketing mix problem. The method utilizes differential evolution optimization. The obtained results show validity and applicability of the proposed approach.

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Keywords: Z-number, reliability, linear programming, multicriteria decision making

1. Introduction

Real-world decision making problems are characterized by imperfect information, particularly, by uncertainty[1], fuzziness[2,3,4,5,6,7,8], partial reliability[10,11,12] etc. For describing fuzziness and partial reliability of information, Prof. L. Zadeh introduced the concept of Z-number[10]. The Z-number valued multi-objective optimization problem and the solution method are considered in[10]. The authors formulated a statement of problem with Z-number valued decision variables, Z-number valued coefficients and right hand sides of constraints, Z-number valued coefficients of objective functions. The concepts of Z-valued feasible solution and Z-valued optimal solution and other concepts are introduced. The solution method is based on differential evolution optimization (DEO).

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This paper is devoted to application of the approach proposed in[12] to solving a marketing mix product problem (MMP). The MMP is one of the important real-world benchmark problems which is characterized by combination of fuzzy and probabilistic uncertainties.

The rest of the paper is organized as follows. In section 2 we present the description of the considered decision problem. Section 3 includes the formal statement of the considered problem in the form of Multiobjective Z-valued linear programming problem. In Section 4 the results of solving the problem formulated in Section 3 are given. Section 5 concludes.

2. Data presentation

A manufacturing company produces products A, B and C and has six processes for production. A decision maker has three objectives: maximizing profit, quality and worker satisfaction. Naturally, the parameters of objective functions and constraints are assigned by Z-numbers. Z-information on manufacturing planning is given in Table 1. Z-information on expected profit, index of quality and worker satisfaction index is given in Table 2.

Table 1. Z-information on manufacturing planning data

Type of resources	Product A (Z_{x_1})	Product B (Z_{x_2})	Product C (Z_{x_3})	Maximum available capacity per month (hours) (Z_{b_i})
1	$Z_{a_{11}} = (about\ 12, \tilde{0.9})$	$Z_{a_{12}} = (about\ 17, \tilde{0.9})$	$Z_{a_{13}} = (about\ 0, \tilde{0.9})$	$Z_{b_1} = (about\ 1400, \tilde{0.9})$
2	$Z_{a_{21}} = (about\ 2, \tilde{0.9})$	$Z_{a_{22}} = (about\ 9, \tilde{0.9})$	$Z_{a_{23}} = (about\ 8, \tilde{0.9})$	$Z_{b_2} = (about\ 1000, \tilde{0.9})$
3	$Z_{a_{31}} = (about\ 10, \tilde{0.9})$	$Z_{a_{32}} = (about\ 13, \tilde{0.9})$	$Z_{a_{33}} = (about\ 15, \tilde{0.9})$	$Z_{b_3} = (about\ 1750, \tilde{0.9})$
4	$Z_{a_{41}} = (about\ 6, \tilde{0.9})$	$Z_{a_{42}} = (about\ 0, \tilde{0.9})$	$Z_{a_{43}} = (about\ 16, \tilde{0.9})$	$Z_{b_4} = (about\ 1325, \tilde{0.9})$
5	$Z_{a_{51}} = (about\ 0, \tilde{0.9})$	$Z_{a_{52}} = (about\ 12, \tilde{0.9})$	$Z_{a_{53}} = (about\ 7, \tilde{0.9})$	$Z_{b_5} = (about\ 900, \tilde{0.9})$
6	$Z_{a_{61}} = (about\ 10, \tilde{0.9})$	$Z_{a_{62}} = (about\ 10, \tilde{0.9})$	$Z_{a_{63}} = (about\ 4, \tilde{0.9})$	$Z_{b_6} = (about\ 1075, \tilde{0.9})$

Table 2. Z-information on profits, quality, and worker satisfaction

Type of objectives	Product A	Product B	Product C
Profit	$Z_{C_{11}} = (about\ 50, \tilde{0.8})$	$Z_{C_{12}} = (about\ 100, \tilde{0.8})$	$Z_{C_{13}} = (about\ 17, \tilde{0.8})$
Quality	$Z_{C_{21}} = (about\ 92, \tilde{0.8})$	$Z_{C_{22}} = (about\ 75, \tilde{0.8})$	$Z_{C_{23}} = (about\ 50, \tilde{0.8})$
Worker satisfaction	$Z_{C_{31}} = (about\ 25, \tilde{0.8})$	$Z_{C_{32}} = (about\ 100, \tilde{0.8})$	$Z_{C_{33}} = (about\ 75, \tilde{0.8})$

3. Statement of problem

The considered MMP problem can be formulated as a Z-valued linear programming problem (Z-LP). Let the quantity produced for X_i be $Z_{X_i},\ i = 1, 2, \ldots, n$ Taking into account Z-information given in tables 1, 2, multi-criteria Z-LP model for multi-criteria planning decision may be formulated as follows.

$$Z_{f_1}(Z_x) = (about\ 50, \tilde{0.8}) \cdot Z_{x_1} + (about\ 100, \tilde{0.8}) \cdot Z_{x_2} + (about\ 17, \tilde{0.8}) \cdot Z_{x_3} \to \max ,$$

$$Z_{f_2}(Z_x) = (about\ 92, \tilde{0.8}) \cdot Z_{x_1} + (about\ 75, \tilde{0.8}) \cdot Z_{x_2} + (about\ 50, \tilde{0.8}) \cdot Z_{x_3} \to \max ,$$

$$Z_{f_3}(Z_x) = \Big[(about\ 25, \tilde{0.8}) \cdot Z_{x_1} + (about\ 100, \tilde{0.8}) \cdot Z_{x_2} + (about\ 75, \tilde{0.8}) \cdot Z_{x_3}) \to \max$$

subject to