APPLICATION OF MCDM DIBR-ROUGH MABAC MODEL FOR SELECTION OF DRONE FOR USE IN NATURAL DISASTER CAUSED BY FLOOD

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Abstract:

Natural disasters around the world have resulted in enormous casualties and economic damage. Floods, as one of the natural disasters caused by climate change and inadequate human attitude towards nature, often create major problems for countries on all continents. Although preventive action is one of the ways to prevent the occurrence of floods, we are witnessing that they continue to happen, so the elimination of the flood consequences and saving lives is given great attention. With the advancement of technology, modern means, machines and devices are increasingly used to rescue people from flooded areas, both to provide assistance to the endangered and their evacuation, as well as to monitor and reconnoiter flood-affected locations. The paper presents the application of the MCDM model DIBR-RoughMABAC in the selection of drones, based on the characteristics of drones, for use during floods, i.e. for surveying flooded areas and delivering necessary materials, food and water. Validation of the model was performed by analyzing its sensitivity to changes in weight coefficients.

Keywords: MCDM, rough MABAC, DIBR, flood, drone

1. Introduction

The unpredictability of climate change, worldwide, significantly affects the increase in the number of natural disasters, especially those of meteorological and hydrological origin. Natural disasters are phenomena that disrupt the normal course of life, resulting in casualties, causing great damage to property or causing loss of property, causing damage to infrastructure and greatly endangering the environment.

The occurrence of large floods often causes the problem of physical access to flooded areas, and for the purpose of reconnaissance of these places, finding people who need help, delivering the necessary medicines, food, water and other necessary materials, drones can be used. Drone (Unmanned Aircraft Vehicle) is a synthesis of unmanned aerial vehicle and a device necessary to control it, i.e. it is an aircraft that can fly without a human operator in it. Depending on their purpose, drones are equipped with different types of sensors and cameras, and their application in different areas indicates the importance of their existence. The basic and essential characteristics of drones are: weight, payload, endurance and range, speed, wing loading, cost, engine type and power.

This paper presents the MCDM model DIBR-RMABAC for the selection of drones for use during floods, i.e. for surveying flooded areas and deliveryinf necessary materials, food and water, based on the characteristics of drones, through two goals. The first goal is to use the DIBR method to obtain weight coefficients, which will clearly reflect the importance of each of the criteria. The second goal refers to the selection of drones, using the RoughMABAC method, with successful and quality treatment of imprecisions and uncertainties.

Also, in the introduction, a literature review related to the research problem was given.

2. Description of MCDM models and methods

MCDM model DIBR-RoughMABAC consists of three phases. The appearance of the model is presented in Fig. 1.

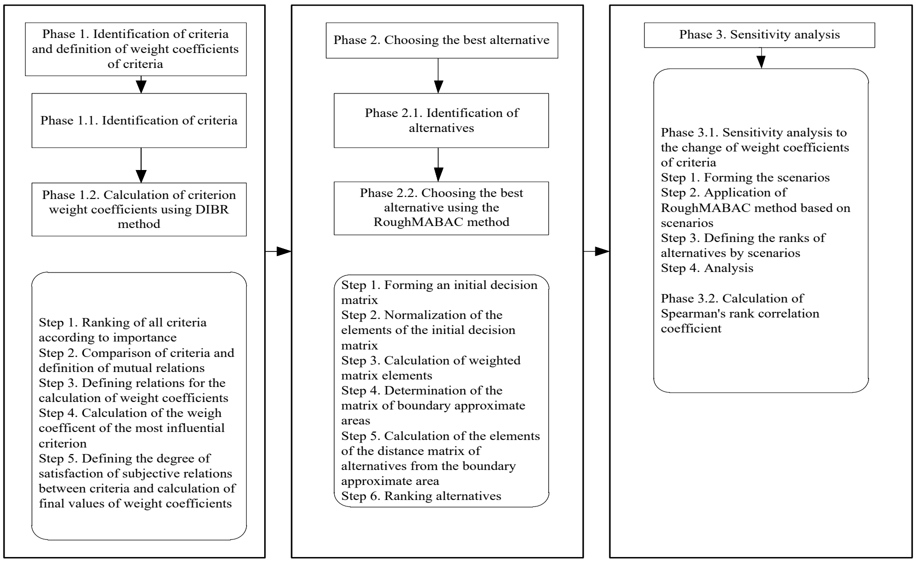

Fig. 1. MCDM model DIBR-RoughMABAC

In the continuation of this part of the paper, a description of the DIBR method, rough numbers and RoughMABAC methods is given, as well as a a literature review related to the methods.

3. Model application and results

By analyzing the available literature and taking into account the specifics of the research problem, the following criteria for the selection of drones are defined (Table 1) and their description is given:

Criteria	
K_1	Cost
K_2	Range
K_3	Load capacity
K_4	Flight speed
K_5	Maximum flight altitude
K_6	Maximum resistance to wind speed
K_7	Flight autonomy

Table 1. Criteria for drone selection

The criteria are ranked in order of importance, from the most important (K_1) to the least important (K_7) for a specific research problem and all are of the benefit type, except for criterion K_1, which is an cost type. Following the phases and steps of the MCDM model, presented in Figure 1, the calculation of the weight coefficients of the criteria was approached using the DIBR method and the following weight coefficients of the criteria were obtained (Table 1):

Criterion	Weight coefficient of the criterion
K_1	0.1916
K_2	0.1841
K_3	0.1569
K_4	0.1391
K_5	0.1167
K_6	0.1121
K_7	0.0994

Table 1. Weight coefficients of the criteria

After obtaining the weight coefficients of the criteria, a ranking of 7 alternatives, which represent 7 different models of drones available on the market, was performed, using the RoughMABAC method, based on the initial decision matrix (X):

$$X = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \\ A_7 \end{array} \begin{array}{c} \begin{array}{ccccccc} K_1 & K_2 & K_3 & K_4 & K_5 & K_6 & K_7 \end{array} \\ \begin{bmatrix} [1300,\ 1450] & [5.4,\ 6] & [1700,\ 2000] & [60.88,\ 68.4] & [5400,\ 6000] & [26,\ 32] & [0.5,\ 0.55] \\ [1300,\ 1350] & [4.5,\ 5] & [425,\ 500] & [44.28,\ 54] & [3560,\ 4000] & [35,\ 41] & [0.49,\ 0.6] \\ [1280,\ 1300] & [5.1,\ 6] & [900,\ 1000] & [48.6,\ 54] & [4100,\ 5000] & [48,\ 52] & [0.45,\ 0.5] \\ [1250,\ 1420] & [5.1,\ 6] & [1620,\ 1800] & [45.05,\ 53] & [4500,\ 5000] & [10.5,\ 13] & [0.54,\ 0.6] \\ [1245,\ 1355] & [5.4,\ 6] & [1275,\ 1500] & [45,\ 50] & [5340,\ 6000] & [25,\ 33] & [0.54,\ 0.6] \\ [1300,\ 1580] & [14.95,\ 16.8] & [720,\ 800] & [44.28,\ 54] & [5340,\ 6000] & [39,\ 49] & [0.44,\ 0.52] \\ [1350,\ 1491] & [5.1,\ 6] & [510,\ 600] & [64.8,\ 72] & [5400,\ 6000] & [32,\ 41] & [0.47,\ 0.53] \end{bmatrix} \end{array}$$

Applying all the steps of the method and the performed ranking (Table 2), it was concluded that alternative A_2 is the most acceptable solution, i.e. it is the best ranked alternative.

	Rank
A_1	6
A_2	1
A_3	2
A_4	3
A_5	4
A_6	7
A_7	5

Table 2. Ranking of the alternatives

4. Sensitivity analysis

In such a complex process, such as decision-making, errors can occur, so the sensitivity analysis of the RoughMABAC method to changes in weight coefficients was performed, through 18 scenarios, where it was concluded that the RoughMABAC method is not significantly sensitive to changes in weight coefficients.

Also, the consistency of the method results was checked by calculating Spearman's rank correlation coefficient (the results are presented in Fig. 2), where it was concluded that the correlation coefficients in the defined scenarios tend towards ideal positive correlation and that the defined MCDM model is stable with respect to weight coefficients. Correlation of ranks was performed in relation to the initial rank, in accordance with the defined scenarios.

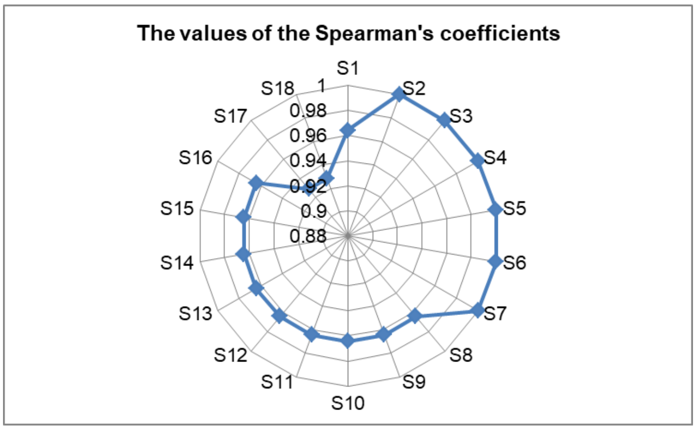

Fig. 2. The values of the Spearman's coefficients

5. Conclusions

In this part of the paper, concluding considerations are given in connection with the research and suggestions for further improvement of the model.

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