The multicriteria estimation of the Russian Federation region districts promising for the logistic objects placement (on the example of the Republic of Tatarstan)

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Abstract. We propose to analyse the multicriteria problem decision making process on the logistic objects placement example and are planning to solve the task in the following steps. We will try to find the alternative optimum to the analysed criteria and ranging the other alternatives beyond the optimum variant which will have the biggest conditional scores volume. The next stage is based on the decision-making person actions which are concerned with the maximizing the rationality in the quasioptimum variants choice. After that basing on the conditions with the big alternative number set the optimum variant could be added by the decisionmaker with the quasioptimum variants (decisions) in three stages. First of all it is necessary to establish the threshold value size in the interactive mode for the next calculations. On the second item of the process the manager mark the significance level for the subsequent set decomposition and then clustering it with the display of the districts multitude (like the images) on a spectral colors manifold (i.e. prototypes). And at last at the third step we propose the adjustment of quasioptimum alternatives number basing on the first choice being guided by the colors of its classes.

It is required to provide the optimum distribution of the Republic of Tatarstan (RT) districts which offer the greatest promise for the logistic objects (LO) creation there that as formulated like a management problem is designated in a tuple (1) with the symbol “t”. Author's approach is based on the preliminary solution of multicriteria decision making task (MC DMT) as the one of the most reliable mathematical tools which is demanded for a wide range of management tasks [1], with the subsequent additional mathematical procedures application [2]:

<\text{t}, \text{X}, \text{R}, \text{A}, \text{F}>, \quad (1)

where “\text{t}” is the studied management problem; \text{X} = \{\text{x}_i\}, i = 1, n = 43 (districts of the RT) is the possible management decisions (alternatives) manifold; \text{R} = \{\text{r}_j\}, j = 1, m = 24 is the multitude of the requirements (criteria) taken into consideration [3]; “\text{A}” is the list of scales criteria (in the input data the criteria are given in interval and binary linguistic scales); “\text{F}” is the display of the alternatives manifold to the criteria list in the two-dimensional array \text{C} = (\text{c}_{ij}) form which elements in the [3] are presented in interval and
linguistic scales. The MC DMT solution is proposed for an optimum alternative $x^{opt}$ finding which could be meet to all the stated criteria at the same time. 

As the additional mathematical procedure for the decision-maker actions is used the fuzzy sets (FS) analysis for the manager immediate ensuring in finding the additional to an optimal solution alternatives manifold (like the quasioptimum subsets $x^{k_{opt}}$).

Together both subsets will create an attractive decision’s subset and the research objective will be in the following formal form:

$$x^{promise} = x^{opt} \cap x^{k_{opt}} ; \quad x^{promise} = k^{op} \cap k_{opt} = x^{opt} \cap k^{k_{opt}}.$$

(2)

For the MC DMT (1) model was chosen the model given in [4]. The criteria according to [4, 5] beforehand were structured in the form of the two-level (close to prof. K. Ishikav’s variant) objects tree (OT) and weighed: $\Omega = \{ o_j \}, j = 1, m = 24$. Then basing on [2, 4] are found a local priorities vector $U = \{ u_{ij} \}$ and a global priorities vector $V = \{ v_i \}$ with the additive convolution (3):

$$v_i = \sum u_{ij} , \quad o_{ij} \quad (in \ the \ conditional \ scores) \quad (3)$$

$$v_{opt} = max \{ v_i \}; \quad k = 26 - \text{is \ the \ number \ from \ list \ X:}$$

$$x^{opt} = x_{26} = "Tukayevsky \ district" \quad 70.40 \text{ scores} = x_1.$$  

The $x^{opt}$ multitude look like the single-point: $k^{opt} = 1$. Other areas are ordered from the $x_1$. For the $x^{k_{opt}}$ assessment we will use the FS analysis. Fuzzy sets (FS) are the couples like the $(x, \mu_A(x))$ type where "x" is the fuzzy set carrier, $\mu_A(x)$ is its accessory degree, and $\mu_A(x) / x = [0; 1]$. A fuzzy sets carrier: $\Sigma A = \{ x | x \in X \ & \ & \mu_A(x) > 0 \}$. FS depth is $h(\Sigma A) = \max \mu_A(x) = a_{max} = 70.40$, and $\mu_A(x) = a_i / a_{max} > 0$

Therefore $\Sigma X = \{ x | x = 1.000; x_{39} = 0.151 \}$. The optimal solution is found in the form of $x^{opt} = "Tukayevsky \ district" \quad 70.40 \text{ scores} = x_1.$

At the 1st stage the decision-maker only states the $\beta$ i.e. the boundary value of a set level

$$X_\beta = \{ x \in X, \mu (x) \geq \beta \} \quad (4)$$

For example, with the $\beta = 0.80 \ k^{promise} = 3$ (see tab. 1, column 4) only a few districts are selected; if $\beta = 0.50$, then with $k^{promise} = 16$ are selected a lot of districts. Let $\beta$ be defined like $\beta = 0.60$, then $k^{promise} = 10$.

At the 2nd stage the decision-maker sets the FS decomposition level $\alpha$ on T. Saati’s scale [3]:

$$\Lambda = U \cdot \alpha \cdot \Lambda \alpha . \quad (5)$$

With the taking into account (4) and (5) we made the clustering by the author's method [6], see tab. 1, column 6. An algorithm of clusters formation: at $i = 1 \ d_i = 1$ forms cluster. For $i > 1$:

$$\left| b_{i+1} = b_i \quad \mid \quad a_{i+1} < \alpha^{crit} \right.;$$

$$\left| d_i = 1 \quad \mid \quad b_{i+1} = b_i + 1 \quad \mid \quad \alpha_{i+1} \geq \alpha^{crit} \right.. \quad (6)$$

At the second stage it is necessary to form the clusters (see tab. 1), for example with the defined $\alpha^{crit} = 5$ ("essential distinctions" on a double quadtree scale). On the 3rd stage and for the method expert opportunities realizing the decision maker must to organize a coloring as the result of spectral colors display (7) to the created classes (see tab. 1, column 8). Let's use the new linguistic variable (LV) $Z_{wet} = \{ z_1, z_2, z_3, z_4, z_5, z_6, z_7 \}$ for example for the decreasing histogram columns coloring.

$$\tau_{color}: A \rightarrow B \quad (7)$$

Basing to the surjection definition $\tau_{color} \text{ display has the injective character relatively to the B}$ prototypes (elements of a range (7)), and as the images A acted the clusters of districts and the each cluster with $\beta = 0.60$ could be corresponds with its own color.

| № | District’s name         | Scores | Grade of membership | Weights, % | Class № | Elem. of cluster № | Color Z |
|---|------------------------|--------|---------------------|------------|---------|-------------------|---------|
| 1 | Tukayevsky             | 70,40  | 1,000               | 5,08       | 1       | 1                 | red     |
| 2 | Almeteyevsky           | 65,19  | 0,926               | 4,71       | 2       | 1                 | orange  |
| 3 | Nizhnekmansky          | 61,66  | 0,876               | 4,45       | 2       | 2                 | orange  |
| 4 | Vysokogorsky           | 54,70  | 0,777               | 3,95       | 3       | 3                 | yellow  |
| 5 | Arsky                  | 51,29  | 0,729               | 3,70       | 4       | 4                 | green   |
| 6 | Laishevsky             | 46,50  | 0,661               | 3,36       | 5       | 5                 | azure   |
| 7 | Mendeleevsky           | 46,11  | 0,660               | 3,33       | 5       | 2                 | azure   |
| 8 | Zelenodolsky           | 46,01  | 0,654               | 3,32       | 5       | 3                 | azure   |
| 9 | Bugulminsky            | 45,84  | 0,651               | 3,31       | 5       | 4                 | azure   |
| 10| Mamadyshsky            | 43,20  | 0,614               | 3,12       | 6       | 1                 | blue    |
In the column 8 table 1 in the decision-maker actions at the 3rd step it is possible to note as an example at least two variants. Variant 1: the “blue column” (Mamadyshsky district) could be estimated by the manager as the unpromising. Then $k^{\text{promise}} = k^{\text{opt}} + k^{\text{kwopt}} = 1 + 8 = 9$ (the Republic of Tatarstan districts). Also is possible the 2nd variant: all “blue columns” which are belonging to the No. 5 class could be marked by the decision-maker as the unpromising. Then $k^{\text{promise}} = k^{\text{opt}} + k^{\text{kwopt}} = 1 + 4 = 5$ (the Republic of Tatarstan districts). Then as the promising cases (or as the "efficient", see [7]) could be accepted the $k^{\text{kwopt}} = 8$ districts or the 4 districts. There also could be other variants. Now it is becoming apparent the singleton set $x^{\text{opt}}$ role: the optimum set could be not only single-pointed if at a clustering (6) to the 1st class will also belong another (others) nearby located districts with the also assigned to them according to display (7) “red color”. So, the proposed problem (2) is solved.

Therefore, basing on the column 8, table 1 the decision-maker here offers the two total variants i.e. it is possible to estimate as the attractive either the first 8 districts, or only the 4 from the 10 earlier selected. This means that the MC DMT solution with the fuzzy analysis using and the decision-maker actions in noted three steps (the first two are formalized) provides the quite objectified way for the proposed objectives pursuing (2).

References

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