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Innovation and presentation of RALSPI model: a new method for evaluating alternatives and assessment of development level of settlements

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Extended Abstract

1- Introduction

In this paper, Ranking Alternatives by Limiting Substitution Possibilities of Indicators (RALSPI) method is proposed as a Multiple Criteria Decision Making (MCDM) method. Many MCDM methods have been developed over the years, but little is known about their shortcomings on similar problems. This study explores the main faults of some of the classical MCDM methods including SAW, TOPSIS, AHP, LINMAP, Numerical Taxonomy and Morris. The rationale for such selection has been that most of these are among the most popular and widely used methods in regional studies of classifying the development level of settlements, and each method reflects a different approach to solve MCDM problems. The RALSPI method resolves significant shortcomings of these methods.

2- Theoretical bases

The typical MCDM problem is concerned with the task of ranking a finite number of decision alternatives, each of which is explicitly described in terms of different characteristics (also often called attributes, decision criteria, or objectives) which have to be taken into account simultaneously. MCDM plays a critical role in many real-life problems; it is hard to accept an MCDM method as being accurate all the time (Wang and Triantaphyllou, 2008). Several methods have been proposed for solving MCDM problems. The major criticism of MCDM methods is that different techniques may yield different results when applied to the same problem, apparently under the same assumptions and by a single DM (Zanakis et al., 1998). Voogd (1983) found that, at least 40% of the time, each technique produced a different result from any other technique.

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Practitioners seem to prefer simple and transparent methods (Hobbs et al., 1992). According to Hobbs et al. (1992) a good experiment should satisfy the following conditions:

Compare methods that are widely used, represent divergent philosophies of decision making or claimed to represent important methodological improvements.

Address the question of appropriateness, ease of use and validity.

Well controlled, uses large samples and is replicable.

Compares methods across a variety of problems.

Problems involved are realistic.

This experiment satisfies all conditions except the fourth one.

3- Discussion

The efficiency of a method is not merely a function of the theory supporting it or how rigorous it is mathematically speaking. The other aspects which are also very important, relate to its ease of using, user understanding and faith in the results, and method reliability (Hobbs et al., 1992).

This section presents a new systematic MCDM approach, RALSPI, for evaluating and ranking alternatives. In fact, the RALSPI is a systematic method for decision problems with many criteria and alternatives. The algorithm for the proposed approach will be developed in eight steps. In this method, decisional process is decomposed into a hierarchy of criteria clusters, criteria, and alternatives. The RALSPI procedure is as follows: (In the RALSPI method, the decision matrix and the weight vector w are given as crisp values a priori.)

Step 1: classifying all criteria into some major categories

First, it is necessary to categorize criteria according to thematic homogeneity. It is preferred that the number of criteria lie in various groups be balanced. This rule facilitates the management of studied criteria. (N: number of all studied criteria; k: number of criteria categories; n: number of criteria related to each category)

Step 2: Normalization of the criteria

The RALSPI method first converts the various criteria dimensions into non-dimensional criteria. For a sets of benefit attributes, each normalized criterion Iij is calculated as follows:

$$I_{ij} = \frac{x_{ij} - x_{\min j}}{x_{\max j} - x_{\min j}}$$

The value of the Iij is computed on a scale of 0–1 where 0 corresponds to the minimum, and 1 to the maximum assigned value for the corresponding indicator.

Step 3: Classifying the amount of Iij into three levels

In this step, three levels for each criterion are defined so that different values are attributed to these levels, as follows:

$$L_1 : 0/80 < I_{ij} \le 1/00 \rightarrow v = 3$$

$$L_2 : 0/50 < I_{ij} \le 0/80 \rightarrow v = 2$$

$$L_3 : 0/00 \le I_{ij} \le 0/50 \rightarrow v = 1$$

Step 4: Defining different groups of development for each criteria category based on sum of the level values

The calculations of this step (formula 1) are separately done for each criteria category which has been represented in step 1.

(1)

$$g = \sum_{j=1}^{n} v_j$$

where g is the level value of development group, n is the number of criteria related to each category, and vj denotes the level value of criterion j.

For example, if one of the major categories consist of 7 criteria and normalized value of all these criteria lie in the interval of (0.80, 1.00], then g=21; because in this example, the level value of each criterion is 3 and so, the sum of the level value of all criteria will be 21. Now, if normalized value of one of these criteria lies in the interval of (0.50, 0.80], then g=20. This means that an increase or decrease in the normalized value of a typical criterion so that it changes the related level value (v) as much as one score, leads to an increase or decrease of the level value of development group (g) as much as one score. Based on this rule, we can define 2n+1 development groups for every criteria category with n criteria. For example, if one of the criteria categories consists of 7 criteria, the number of development groups will be 15. In this example, maximum and minimum level value of development group is 21 and 7, respectively. The level value of 21 is related to the condition in which normalized value of all 7 criteria lie in the interval of (0.80, 1.00], and the level value of 7 occurs when normalized value of all criteria lie in the interval of [0.00, 0.50]. Process of calculating the level value of development group of major criteria categories is presented in Table 1.

Table 1. Process of calculating the level value of development groups of major criteria categories

Development group	level value					level value of development group (g)
	criterion 1	criterion 2	criterion 3	....	criterion n	
group 1th	○ v=3	○ v=3	○ v=3	....	○ v=3	3n
group 2th	○ v=3	○ v=3	○ v=3	....	○ v=2	3n-1
⋮	⋮	⋮	⋮	....	⋮	⋮
group (2n+1)th	○ v=1	○ v=1	○ v=1	....	○ v=1	n

Based on this procedure, maximum and minimum of g will be 3n and n, respectively.

Step 5: Specifying the possible maximum and minimum score for each of the development groups

This step is devoted to calculating the possible maximum and minimum scores of Development groups.

In RALSPI method, each appraisal criterion is not assumed to be of equal importance because the appraisal criteria have various meanings. There are many methods that can be employed to determine weights, such as the eigenvector method, weighted lease square method, entropy method, AHP etc. The method which is chosen depends on the nature of the problem. However, for a given criteria weight vector w(w1, w2, …, wn) where ∑wj=1, the weighted normalized criterion can be calculated by multiplying its normalized form (Iij) with its associated weight (wj).

The possible maximum score of development for each group ($P_{\max S_g}$) is the possible highest value of sum of the weighted criteria, and the $P_{\min S_g}$ is the lowest one.

(2)

$$P_{\max S_g} = p_{\max}\{\sum_{j=1}^{n} I_j w_j\}$$, g = n, n+1, ..., 3n

(3)

$$P_{\min S_g} = p_{\min}\{\sum_{j=1}^{n} I_j w_j\}$$, g = n, n+1, ..., 3n

Step 6: Calculating the level value of development group (g) of alternatives with respect to each of the major criteria categories

In this step, one of the tripartite values (v=1 or 2 or 3) is assigned to each alternative with respect to each criterion, based on its performance (criterion normalized value). Then, for each alternative, related development group and g value in each major criteria category is determined.

Step 7: Calculating score of alternatives with respect to each individual major criteria category by formula (4)

(4)

$$S_{ik} = \frac{\sum_{j=1}^{n} I_{ij} w_j}{P_{\max S_{g_i}}} \times P_{\min S_{(g_i+1)}}$$

Step 8: Calculating total scores for each individual alternative

The total scores for alternatives are computed by summing their values of the all criteria categories.

(5)

$$S_i = \sum S_{ik}$$

The value of Si lies in the interval [0, 1]. The best decision alternative will be the one with the biggest overall value in this interval.

4- Conclusion

This paper presents a new Multiple Criteria Decision Making (MCDM) approach, i.e., Ranking Alternatives by Limiting Substitution Possibilities of Indicators (RALSPI), for solving multiple criteria problems. In fact, RALSPI is a new, simple, and straightforward evaluating system with a coherent methodological basis, and resolves significant shortcomings of other current related methods; so, this method is proposed to evaluating alternatives and assessing development level of settlements.

Keywords: Evaluating alternatives, Assessment of development level, Multiple Criteria Decision Making, RALSPI model, Iran.

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