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Multiple Criteria Decision Making (MCDM) – Part 3

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Multiple criteria decision making (MCDM) - summary of the previous lecture

Our aim in MCDM problems is to choose the compromise alternative from the list of alternatives which are evaluated under several criteria.

However, the choice of compromise solution depends on the choice of the weights and MCDM method, there are some basic properties which every method should satisfied and we never should choose a dominated alternative.

Prototype example (from the previous lecture)

We want to buy a tent. We are interesting in the weight of the tent, waterproof rating, expert evaluation and price. We are thinking about following five types of tents (we like them, they have such properties which we need), the data are in the table.

Produkt	**weight**	**waterproof**	**expert**	**price**
Type 1	2.4 kg	1200mm	3	3990 CzK
Type 2	2.5 kg	1600mm	2	4500 CzK
Type 3	2.7 kg	1500mm	2	4700 CzK
Type 4	3.5 kg	400mm	5	1990 CzK
Type 5	3 kg	1000mm	4	2500 CzK

Transformation of the type of objective function

In many real-life problem we have typically both kinds of type of objective function – cost and benefit types. However some methods need to have all criteria in benefit type. How to transform cost-type objective function into benefit-type?

Several ways how to transform type of objective function

$\min f(x) \Leftrightarrow max - f(x)$
$\min f(x) \Leftrightarrow max 1/f(x)$
$\min f(x) \Leftrightarrow maxM - f(x)$

Transformation of the type of objective function

Let us suppose that we search for x such that $f(x)$ has to be maximized. Hence, if $f(x) \neq 0$, it is equivalent to search for x such that $\frac{1}{f(x)}$ is minimized. However in economics problem, there is a problem of interpretation of the values $\frac{1}{f(x)}$. O

The next possibility is to use transformation $\frac{\min_j r_{ij}}{r_{ij}}$ (where $\min_j r_{ij}$ is the optimum under this criterion. The main advantage of this transformation is that it is ensured that all transformed values are less than or equal to 1, the achievement of the value 1 means the achiement of optimum. (However, it is not possible to apply this method in case of zero value existence.)

Conjunctive methods

We choose only such alternatives which fulfill conditions under all criteria.

Disjunctive method

We accept all alternatives which fulfill the given conditions at least under one criterion.

Lexicographical method

We compare the alternatives under the most important criterion, in case of two best alternative, we compare them under second criterion and so on.

Lexicographical method - plus and cons

The main advantage of this method is that it is very easy to use, on the other hand it takes into account evaluation under only one criterion, what is very important disadvantage.

Rank method

We use it in case when we have only ordinal information about alternatives preference under criteria. It is based on weighted rank of alternatives.

$$\mathbb{Z} = (z_{ij} = v_i r_{ij}).$$

Then we put

$$p_i = \sum_j z_{ij}.$$

The best alternative has the smallest value of p.

Rank method – solution of Prototype example

Point method

The principle of this method is similar to the Prefence point method for the criteria weight construction. We need to have cardinal information about all alternatives under all criteria, then we assing points (utility) and apply weighted sum.

Weighted Sum Method (WSM)

In fact, this method can be also called as a method of linear utility function. (In case, when we suppose linear utility function, then this method is equivalent to maximization of weighted utility. In the first step of this method, we use following standardization:

$$s_{ij} = \frac{r_{ij}}{\max_j r_{ij} - \min_j r_{ij}}.$$

The main advantage of this method is its simplicity. On the other hand, the main disadvantage of this method is a possible dependence on an added dominated alternative. The way how to handle this problem is a usage of conjunctive and disjunctive methods before the optimisation.

TOPSIS, ELECTRE and others

Many methods od MCDM exist, some of them are computationally simple, some of them quite complicated. Since, MCDM methods are widely used, many SW for MCDM exist, in this course we use a Excel Macro SANNA. SANNA was developed at University of Economics in Prague and it involves several basic MCDM methods. It can be downloaded from nb.vse.cz/ $\sim$ jablon.