Application of Multi Criteria Decision Making Tools and Validation with Optimization Technique-Case Study using TOPSIS, ANN & SAW

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Abstract
Multi-criteria decision making has been one of the fastest growing areas during the last decades depending on the changing's in the business sector. Decision maker(s) need a decision aid to decide alternatives and mainly excel less preferable alternatives fast. With the help of computers the decision making methods have found great acceptance in all areas of the decision making processes. Since multi-criteria decision making (MCDM) has found acceptance in areas of operation research and management science, the discipline has created several methodologies. It is difficult to find intelligent students by considering the factors. In these paper students with intelligent level is analyzed and ranked by TOPSIS and SAW. Obtained results are validated by ANN and the obtained results were compared. Therefore, the aim of this paper is to extend the TOPSIS and SAW method to decision-making problems and validation using ANN.

Keywords
Multi-Criteria Decision Making (MCDM), Intelligent Level, Artificial Neural Network, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Simple Additive Weighting (SAW).

I. Introduction
Decision analysis looks at the paradigm in which an individual decision maker (or decision group) contemplates a choice of action in an uncertain environment. The theory of decision analysis is designed to help the individual make a choice among a set of pre-specified alternatives. The decision making process relies on information about the alternatives. The quality of information in any decision situation can run the whole gamut from scientifically-derived hard data to subjective interpretations, from certainty about decision outcomes (deterministic information) to uncertain outcomes represented by probabilities and fuzzy numbers. This diversity in type and quality of information about a decision problem calls for methods and techniques that can assist in information processing. Ultimately, these methods and techniques may lead to better decisions.Since multi-criteria decision making (MCDM) has found acceptance in areas of operation research and management science [5], the discipline has created several methodologies. Especially in the last years, where computer usage has increased significantly, the application of MCDM [1] methods has considerably become easier for the users the decision makers as the application of most of the methods are corresponded with complex mathematics.

II. TOPSIS Method
Technique for order performance by similarity to ideal solution (TOPSIS) [6], one of known classical MCDM method, was first developed by Hwang and Yoon for solving a MCDM problem. TOPSIS [2], known as one of the most classical MCDM methods, is based on the idea, that the chosen alternative should have the shortest distance from the positive ideal solution and on the other side the farthest distance of the negative ideal solution. The TOPSIS-method will be applied to a case study, which is described in detail.

III. SAW Method
Simple Additive Weighting (SAW) [10] is probably the most used (and abused) MCDA method. It is intuitive and easy. Simple Additive Weighting (SAW) which is also known as weighted linear combination or scoring methods is a simple and most often used multi attribute decision technique. The method is based on the weighted average. An evaluation score is calculated for each alternative by multiplying the scaled value given to the alternative of that attribute with the weights of relative importance directly assigned by decision maker followed by summing of the products for all criteria. The advantage of this method is that it is a proportional linear transformation of the raw data which means that the relative order of magnitude of the standardized scores remains equal.

IV. ANN Method
For the validation process by ANN [2] is followed, the human brain provides proof of the existence of massive neural networks that can succeed at those cognitive, perceptual, and control tasks in which humans are successful. The brain is capable of computationally demanding perceptual acts (e.g. recognition of faces, speech) and control activities (e.g. body movements and body functions). The advantage of the brain is its effective use of massive parallelism, the highly parallel computing structure, and the imprecise information-processing capability. Hence the student stress is dealing with the biological factor ANN is the best method to validate problems associated with it. Artificial neural networks (ANN) have been developed as generalizations of mathematical models of biological nervous systems.

V. Methodology
For the analysis of this paper the four broad categories are performed.

i. Pilot Study:
In the study of psychological outcomes in relation to a postulated negative event, it is important to ask ourselves what the "negative issue" being investigated is. Especially with respect to international subjects, the question that needs to be addressed is whether the negative event is relevant for the group under study. Different stress compared among college students using a questionnaire designed to assess general life stress, and found that the former group reported fewer stressful events and analyzed.

ii. Validation:

The question before the researcher is that the questionnaire he is adopting will measure what it is supposed to measure and will do this in a consistent manner. Now, before we start discussing the answer to this question let us go through the definitions for and methods of establishing the validity and reliability of a questionnaire.

iii. Sample Size Determination

Example, Total population of EEE department is 500.In case of finite population stated formula for determining sample size is

n= Z2 N σ2/ (N-1) e2+z2σ2p (1)

Here, n= sample size, N= population, e= acceptable error (precision)

σp=standard deviation of population (to be estimated from past experience or on the basis a trial sample).

Z=standard variant at the given confidence interval.

From our pilot study we have to find out standard deviation of 100 sample isσp= 3.3582

Z=1.96 (from normal distribution table)

e=z σp/√n (2)

e=1.96*3.3582/√100; e=0.638607.

We have to apply the all the above values to eqn (1)

n=1.962 * 500*3.25822/ ((500-1)*0.6386072) +1.962*3.25822

Get n=83.47402. But,

We have to choose the sample size for our study is 40.It more than enough to conduct the study.

VI. Case Study with TOPSIS

TOPSIS [6] assumes that we have m alternatives (options) and n attributes/criteria and we have the score of each option with respect to each criterion.

Let xij score of option i with respect to criterion j

We have a matrix X = (xij) m×n matrix.

Step 1

Calculate the weights of the evaluation criteria. To find the relative normalized weight of each criterion, first of all, the geometric mean of ith row in the pair-wise comparison matrix is calculated by

$$\text{GMi}=\sqrt[n]{\prod_{j=1}^{n} X_{ij}} \quad i=1,2, \quad .m \tag{3}$$

Then, geometric means of the rows in the comparison matrix are normalized as:

$$\text{Wi}=\text{GMi} / \sum_{i=1}^{m} GMi \quad i=1,2, \quad .m \tag{4}$$

Step 2

Construct the normalized decision matrix. This step converts the various attribute dimensions into non dimensional attributes. An element rij of the normalized decision matrix R is calculated as follows:

$$\text{Rij}=\frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}^{2}} \text{ , i=1,2,….m; j=1,2,….n}$$

$$\text{Where N}=\left\lfloor R_{ij} \right\rfloor_{m\times n} \tag{5}$$

Step 3

Calculate the weighted normalized decision matrix (V). The weighted normalized value vij is calculated as:

$$\text{Vij=wjrij , i=1,2,….m;j=1,2,….n}$$

$$\text{Where V}=\left\lfloor v_{ij} \right\rfloor_{m\times n} \tag{6}$$

Step 4

Identify the positive ideal solution and negative ideal solution.

$$\overset{*}{A} = \{\overset{*}{V}_1, \overset{*}{V}_2, ..., \overset{*}{V}_n\} = \{(\max_j v_{ij} \mid i \in I'), (\min_j v_{ij} \mid i \in I'')\} \tag{7}$$

$$\bar{A} = \{\bar{V}_1, \bar{V}_2, ..., \bar{V}_n\} = \{(\min_j v_{ij} \mid i \in I'), (\max_j v_{ij} \mid i \in I'')\} \tag{8}$$

Step 5

Calculate the separation measure. In this step the concept of the n-dimensional Euclidean distance is used to measure the separation distances of each alternative to the ideal solution and negative-ideal solution. The corresponding formulas are the separation from the positive ideal alternative is:

$$S_i^* = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^*)^2}, \qquad \text{i=1,2,….m.} \tag{9}$$

Similarly, the separation from the negative ideal alternative is:

$$S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2}, \qquad \text{i=1,2,….m} \tag{10}$$

Step 6

Calculate the relative closeness to the ideal solution. The relative closeness of the alternative Ai with respect to A* is defines as:

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-} \text{ ,} \qquad \text{i=1,2,….m} \tag{11}$$

Where $0 \le C_i^* \le 1$ that is, an alternative i is closer to A* as C_i^* approaches to 1.

Step 7

Rank the preference order. Choose an alternative with maximum Ci* or rank alternatives according to Ci* in descending order.

VII. Case Study with SAW Method

Process of SAW consist of these steps:

Step 1:

In order to calculate computing Weighted Sum Vector (WSM)

Step 2:

Calculate the normalized decision matrix for positive criteria:

i=1,... 40, j=1,... 5

And for negative criteria:

i=1,... 40, j=1,... 5

So in this case of study, criteria have positive according to the objective.

r*j Is a maximum number of r in the column of j.

Step 3:

The simple additive weighting method evaluates each

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alternative, Ai. By the following formula:

$$A_i = \sum w_j . x_{ij}$$

i=1,... 40, j=1,... 5

Where xij is the score of the ith alternative with respect to the jth criteria, wj is the weighted criteria.

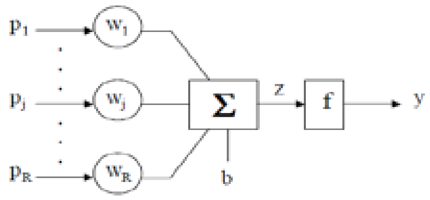
VIII. Validation with ANN

An artificial neuron [3] is a device with many inputs and one output. The neuron has two modes of operation; the training mode and the using mode. In the training mode, the neuron can be trained to fire (or not), for particular input patterns. In the using mode, when a taught input pattern is detected at the input, its associated output becomes the current output. If the input pattern does not belong in the taught list of input patterns, the firing rule is used to determine whether to fire or not.

Table 1 :

Student No	Verbal Ability	Aptit-ude	Commu-nication	Acad-emic	Data Interpre-tation
1	44	56	78	32	43
2	45	76	55	65	76
3	45	67	83	44	56
4	23	44	98	55	33
5	44	99	76	77	55
6	81	72	33	45	67
7	34	99	51	71	81
8	34	66	99	11	34
9	34	71	82	34	36
10	45	41	71	81	41
11	81	54	36	73	12
12	44	51	81	41	84
13	41	45	44	36	72
14	43	71	32	31	41
15	91	23	45	77	63
16	92	42	76	42	81
17	43	76	82	91	54
18	34	62	41	52	97
19	42	64	85	92	11
20	36	42	78	93	24
21	32	51	42	73	92
22	81	75	82	36	41
23	53	48	72	83	42
24	23	56	93	54	57
25	64	83	41	37	52
26	62	73	48	91	55
27	26	71	62	54	33
28	37	41	67	34	66
29	61	78	93	25	67
30	41	64	58	93	42
31	32	53	51	68	31
32	82	51	94	37	82
33	42	61	54	62	71
34	38	41	27	82	35
35	71	32	42	67	84
36	65	34	11	23	86
37	65	85	43	21	21
38	42	76	73	82	32
39	14	52	54	67	81
40	23	54	53	47	81

McCulloch-Pitts model of an artificial neuron



$$y = f(w_1 \cdot p_1 + \ldots + w_j \cdot p_j + \ldots w_R \cdot p_R + b)$$

$$y = f(\boldsymbol{W} \cdot \boldsymbol{p} + b)$$

$\boldsymbol{p} = (p_1, \ldots, p_R)^T$ is the input column-vector

$\boldsymbol{W} = (w_1, \ldots, w_R)$ is the weight row-vector

IX. Discussion Analysis & Results

The results obtained are as follows,

The various level of questionnaire was carried among students and the major five below factors is considered. With of this below table it is difficult to say, which student has most intelligent level? Thus with the MCDM tools [4] intelligent level can be determined is as shown,

Table 2 : SAW RESULTS

Rank	Student no	Ci* value
1	5	862065042
2	17	809685214
3	32	733352226
4	26	668567137
5	16	614285375
6	7	607033713
7	2	571348249
8	29	455729722
9	22	452097024

Student are arranged according to their intelligent level

Table 3 : TOPSIS,ANN & SAW RESULTS

Rank	Student no	Ci* value
1	5	0.72235
2	17	0.711171
3	32	0.6968
4	26	0.688155
5	16	0.663965
6	29	0.662241
7	2	0.645196
8	22	0.62688
9	38	0.627662

Thus obtained results both by TOPSIS, SAW and ANN are the same. Three MCDM [11] tools are compared, it can be noted that student with intelligent level in above table is similar.

Table 4 :

Rank	Student no	Ci* value
1	5	0.7618

2	17	0.7380
3	38	0.6662
4	7	0.6516
5	29	0.6499
6	19	0.6465
7	22	0.6257
8	3	0.6191
9	24	0.6159

X. Conclusion

It is quite clear that selection of student's intelligent factor involves a large number of considerations. The use of TOPSIS method is observed to be quite capable and computationally easy to evaluate and select significant effect of stress from a given data. TOPSIS method uses the measures of the considered criteria with their relative importance in order to rank the student with respective results. Thus, this popular MCDM [14] Method can be successfully employed for solving any type of decision-making problems having any number of criteria and alternatives in the manufacturing domain. The obtained results were compared both with TOPSIS, SAW and ANN [13], thus the student with high intelligent level are ranked. The extension of this paper is validated by ANN [8]. As a future scope, statistical analysis of data can also be developed to aid the decision makers to take decisions in presence of imprecise and appropriate data.

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