Mathematical Model for Performance Rating in Software industry- A study using Artificial Neural Network

E.Manokaran, S.Senthilvel, S.Subhashini, Dr.R.Muruganandham, Dr.K.Ravichandran

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 the performance of employees by considering the factors. In these paper employees performance level is analyzed and ranked by TOPSIS and SAW methods. Obtained results are validated using ANN and the results were compared. Even the problem with both the objective function is complex by solving MCDM. Hence Optimization Method of approach to a problem is analyzed and further comparison is made.

Index Terms— ANN, MCDM, Performance level, SAW, TOPSIS

1 Introduction

Multi-criteria decision analysis (MCDA), sometimes called multi-criteria decision making (MCDM) [1] is a discipline aimed at supporting decision makers faced with making numerous and sometimes conflicting evaluations. MCDM consists of constructing a global preference relation for a set of alternatives evaluated using several criteria and selection of the best actions from a set of alternatives, each of which is evaluated against multiple, and often conflicting criteria. Further the objective function with both positive and negative criteria is solved through Optimization Technique which is more complex by MCDM. Therefore, the aim of this paper is to compare the various MCDM tools to decision-making problems, to determine parameter analysis compared with other methods and the mathematical approach of solving the problem with both the function.

2 Topsis Method

Technique for order performance by similarity to ideal solution (TOPSIS) [2], one of the known classical MCDM methods was first developed by Hwang and Yoon for solving MCDM problems. TOPSIS 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.

3 Saw Method

Simple Additive Weighting (SAW) is probably the most used and abused MCDA method. It is intuitive and easy. Simple Additive Weighting (SAW) [3] 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.

4 Ann Method

For the validation process ANN [6] 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 employee 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.

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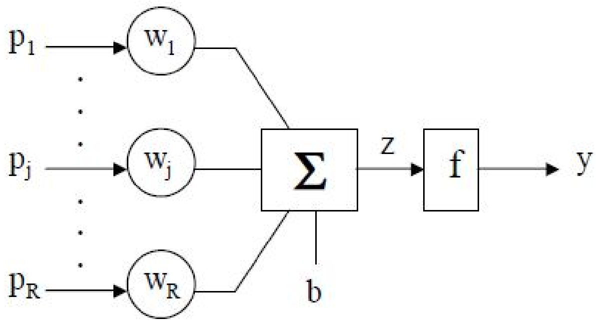

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FIG 1: MCCULLOCH-PITTS MODEL OF AN ARTIFICIAL NEURON

$Y = f(W_1.p_1 + \ldots. + W_j.p_j + \ldots.+W_R.p_R+b)$ …. (1)

$Y = f(W.p+b)$ …. (2)

$p = (p_1 \ldots.\ p_R)^T$ is the input column vector

$W = (W_1 \ldots.\ W_R)$ is the weight row vector

5 DATA COLLECTION

Questionnaire was framed and detailed survey was carried among the employees and the dominant factors were only considered for the study. It is difficult to say that which employee has the best performance level from the below table.

TABLE 1

Employee No	Verbal Ability	Aptitude	Communication Skills	Academic	Data Interpretation
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

LIST OF EMPLOYEE'S FACTORS SCORES FOR PERFORMANCE ANALYSIS
(SINGLE OBJECTIVE FUNCTION-MAXIMIZATION)

Emp. No	Verbal Ability	Aptitude	Communication Skills	Academic	Data Interpretation	No of Days Absent (in a year)	Frequency Of Lateness
1	44	56	78	32	43	20	10
2	45	76	55	65	76	11	22
3	45	67	83	44	56	24	11
4	23	44	98	55	33	45	23
5	44	99	76	77	55	30	33
6	81	72	33	45	67	11	49
7	34	99	51	71	81	11	28
8	34	66	99	11	34	10	20
9	34	71	82	34	36	48	23
10	45	41	71	81	41	36	33
11	81	54	36	73	12	18	42
12	44	51	81	41	84	44	12
13	41	45	44	36	72	20	32
14	43	71	32	31	41	37	10
15	91	23	45	77	63	33	27
16	92	42	76	42	81	21	28
17	43	76	82	91	54	47	21
18	34	62	41	52	97	22	4
19	42	64	85	92	11	18	32
20	36	42	78	93	24	24	51
21	32	51	42	73	92	21	3
22	81	75	82	36	41	11	12
23	53	48	72	83	42	23	32
24	23	56	93	54	57	43	26
25	64	83	41	37	52	14	36
26	62	73	48	91	55	29	32
27	26	71	62	54	33	12	32
28	37	41	67	34	66	46	39
29	61	78	93	25	67	22	34
30	41	64	58	93	42	43	23
31	32	53	51	68	31	33	32
32	82	51	94	37	82	12	28
33	42	61	54	62	71	40	23
34	38	41	27	82	35	23	32
35	71	32	42	67	84	28	32
36	65	34	11	23	86	48	34
37	65	85	43	21	21	23	32
38	42	76	73	82	32	26	43
39	14	52	54	67	81	12	2
40	23	54	53	47	81	29	43

TABLE 2
LIST OF EMPLOYEE'S FACTORS SCORES FOR PERFORMANCE ANALYSIS
(TWO OBJECTIVE FUNCTION-MAX & MIN)

6 Results

☠ Above tables shows the result of employees subjected to more stressed

Comparison	Sensitivity Analysis	Large No of Criteria	Decision Maker's Support	Time Analysis
TOPSIS	3	4	2	2
SAW	2	3	3	4
ANN	3	2	3	4

7 Multi Criteria Decision Method-Parameter Comparison

***1-5** for **lower** to **best** values.

Different Methods is analyzed and the grades were given based on evaluating the weight.

➢ **Sensitivity Analysis:**

The decision maker can make better decisions if he/she can determine how critical each criterion is. In other words, how sensitive the actual ranking of the alternatives is to changes on the current weights of the decision criteria.

➢ **Large Numbers of Criteria:**

As the criterion becomes large for some of the alternatives, The MCDM technique can support to its own weight age. Hence grades have been given based on the MCDM support to large number of criteria or attributes.

➢ **Decision Makers Support:**

According to the Decision Maker the appropriate weight-age can be given. Hence grades have been given based on the decision maker support to the MCDM.

➢ **Time Analysis:**

The time taken for the solving the problem with different criteria differs. Hence the grades given to MCDM tools based on their time taken to solve the problem.

8 Mathematical Model

In optimization models the requirements come from the relationships that must hold among the decision variables and the various static or dynamic structural elements by the nature of system operation. Each requirement leads to a constraint on the decision variables that will be expressed as a mathematical equation or inequality in the model for the problem. The model also includes any bounds (lower and/or upper) that the decision variables or some functions of them must satisfy in order to account for the physical limitations under which the system must operate.

We know that if an objective function is a cost function (profit function) we would like to minimize (maximize) it. Fortunately, it is not necessary to consider minimization and maximization problems separately, since any minimization problem can be transformed directly into a maximization problem and vice versa. For example, to maximize a function f(x) of decision variables x, is equivalent to minimizing −f(x) subject to the same system of constraints, and both these problems have the same set of optimum solutions. Also, we can use

$$\left(\begin{array}{l}\text{Maximum value of } f(x)\\ \text{subject to some constraints}\end{array}\right) = -\left(\begin{array}{l}\text{Minimum value of } -f(x)\\ \text{subject to the same con-}\\ \text{straints}\end{array}\right) \quad \ldots (3)$$

9 Conclusion

It is quite clear that selection of employee's performance 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 employee with respective results. Thus, this popular MCDM [4] 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 [3] and ANN [5], thus the employee with high performance level are ranked. The extension of this paper is validated by ANN. The parameter analyses for the MCDM tools are also stated with different grades. For the problem with multi-Objective function MCDM tools is not sufficient, hence mathematical model is suggested and still improvement in mathematical model can be made . As a future scope, objective function with ranges of problem with different constraint can be formulated.

References

[1] R. Venkata Rao, PhD, Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, Springer. "*Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making Methods*".

[2] Vijay Manikrao Athawale, Shankar Chakraborty Proceedings of "*A TOPSIS Method-based Approach to Machine Tool Selection*" the 2010 International Conference on Industrial Engineering and Operations Management Dhaka, Bangladesh, January 9 – 10, 2010.

TOPSIS RESULTS

Rank	Employee 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

SAW RESULTS

Rank	Employee 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

ANN RESULTS

Rank	Employee 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

ISSN 2229-5518

[3] Alireza Afshari, Majid Mojahed and Rosnah Mohd Yusuff. "*Simple Additive Weighting approach to Personnel Selection problem*" International Journal of Innovation, Management and Technology, Vol. 1, No. 5, December 2010 ISSN: 2010-0248.

[4] Farnaz Akhavi and Caroline Hayes "*A Comparison of Two Multi-Criteria Decision-making Technique*", IEEE, 2003, pp956-961.

[5] Coryn A.L. Bailer-Jones Max-Planck-Institute for Astronomie, K¨onigstuhl "*An introduction to artificial neural networks*", pp.69-117.

[6] Ajith Abraham Oklahoma, The Book "*Artificial Neural Networks*" State University, USA.

[7] S. R. Gangurdel, M. M.Akarte, "*Ranking of Product Alternatives Based on Customer-designer Preferences*" Proceedings of the 2010 IEEE IEEM978-1-4244-8503-1110, IEEE.

[8] Anil Jadhav, Rajendra Sonar"*Analytic Hierarchy Process (AHP), Weighted Scoring Method (WSM), and Hybrid Knowledge Based System (HKBS) for Software Selection: A Comparative Study*" Second International Conference on Emerging Trends in Engineering and Technology, ICETET-09, Indian Institute of Technology Bombay, India.

[9] Jun-Jie Lv, Yuan-Zhuo Wang"*A Ranking Method for Information Security Risk Management based on AHP and PROMETHEE*", This paper is supported by National Natural Science Foundation of China (No.60803123, No. 60873193). 978-1-4244-5326-9 / 10©2010 IEEE.