Journal of Industrial Strategic Management

Indifferent Points in The Multicriteria Decision Making Problems (A Case Study of Suppliers' Evaluation in Zanjan Province Gas Company)

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CHRONICLE

Article history:
Received: *04/07/2017*
Received in revised: *08/18/2017*
Accepted: *10/11/2017*

Keywords:
** Indifference Points*
** Marginal Rate of Substitution*
** Metaheuristic Algorithms*
** Parallel Matrixes*

Abstract

Evaluating and selecting the right contractors can increase the chances of success of a project and the organization. Considering the intense competition faced by organizations today, proper cost management to enhance profitability and customer satisfaction has attracted a lot of attention. The evaluation of contractors is usually a process that is based on various criteria. By the end of it, the appropriate options are selected. Given the diversity in the criteria and among the decision-making subjects, no single way has been offered to suggest substitution between criteria. The desirability indifference on the curve of consumption of various goods (selection of decision-making options) is the same. This paper seeks to identify parallel matrices with the initial decision-making matrix of contractors that have the same results and desirability for decision-makers (indifference points). At first, the initial rating using the AHP and TOPSIS methods and the particle swarm optimization (PSO) and genetic algorithm (GA) techniques, along with MATLAB software, was used to identify the parallel matrices. According to the obtained results, six parallel matrixes with the initial decision-making matrix that had been prepared by experts from the company were produced. Out of them, the matrix related to The point of indifference is the fifth output5 AHP-PSO, based on the company experts' opinions was selected as the final version.

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Introduction

The selection of contractors playsa significant role in the success or failure of projects. Evaluating and selecting the right contractor can increase the chance of success of a project and the organization [15]. In recent times, competition has increased in all fields.The only organizations that survive are those thatuse their resources in the best and most efficient way [31]. Given the intense competition faced byorganizations today, proper cost managementto enhance profitability and customer satisfaction has attracted a lot of attention [30].

Managers and decision-makers can utilize policies to survive in this space.But the final desirable result will occur only when a detailed and comprehensive planis used [35].

Decision-making constitutes an important part of our lives.We have to makesmall and big decisions every day. The decisions we make affectour lives.We take power through selections and decisions. So far, many definitions of decision-making havebeen provided that look at it as an individual's selection.An individual chooses from among different options that may be limited or unlimited.In the most optimistic case, a few of our decisionsare fully implemented. One of the reasons for not implementing some decisions is the lack of flexibility in the organization's resources and facilities. As has been explainedin definitions related to decision-making, decision-making is aprocess through which a specific issue or solution is chosen [32].Another definition looks at it asa process in which certain practicalmethodsare chosen to resolve a particularissue [20].

In all these definitions, the selection of one option among many available options is considered. Today, there are thousands of papers and books about decision-making, especially multi-criteria decision-making (MCDM), and the number is growing every day. Only between 1987 and 1992, in the field of MCDM, about 1,216 papers, 208 books, 31 related scientific journals, and 143 conference papershave been published [3]. MCDM is categorized into two categories: multi-objective decision-making (MODM) and multi-attribute decision-making (MADM). MADM refers to certain decisions (the preferred type) such as assessments, priorities, and choosing from the available options (which sometimes may include several conflicting indices).

MADM problems in the literature on MCDM are categorized into two groups: the non-compensatory and compensatory models [4]. The compensatory model consists of methods that allow the exchange of permission among indices—that is, a change (probably small) in an index would be compensated by the opposite change in another index (or indices). Considering the available diversity in the criteria and among the decision-making subjects, a specific method for this paper has not been offered [27].Also, there is no technique that can produce scientifically points of indifference

with the modelling of the decision-making initial matrix for more action freedom of organization. Among the studies focussing on the development of MCDM models ,indifference curves, and the marginal rate of substitution ,notable are the studies of Kou, Peng, and Wang (2014); Mulliner, Malys, and Maliene (2016); Hwang, Wang,Salaty, and Makuyi (2012);Hosseini and Kazemi (2015); and Amiri and colleagues (2012) [1], [3].

The points on an indifference curve indicate a combination of two goods (or alternatives) that have the same desirability in terms of consumption. One of the ways toconsider substitutation objectively among the available indices of anissue in MADM isthe marginal rate of substitution (MRS)method [6]. The substitution or exchange rate is anunderlying assumption for this procedure.It is thenecessary change amount in the present value of an index against a change unit of some other index for the existence of certain circumstances [4].

Say,two major indices—x1 and x2—havedrawnyour attention whileyou were buying a car (the effect of other indices is the same for you).You are asked, for example, if x2 as Δ increases, by how much x1 should be reduced untilyou as the decision-maker remain indifferent in your decision-making in terms of desirability? In most cases, the answer to this question will depend on the available number of x1 and x2.If,givena certainlevel of x1 and x2,you wish to reduce λΔ unit of x1 for a Δ unit increase from x2, then your MRS from x1 vis-à-visx2 is equal to λ.

In other words, λ is equal to the amount of x1 that youare wanting to lose (bypaying a fine) against gaining a unit more than x2 [4]. Usually,MADM problems, according to experts' scores ofthe identified criteria and themethods used, lead to a ranking among the options. In this paper, based on the judgment (ranking) of experts, an attempt is made to identify several conditions that brings us to this ranking. According to the conditions and resources of an organization, there may be more appropriate conditions to achieve this ranking. This paper seeks to identify the parallel matrices with the primary matrix of decision-making that have the same desirability for decision-makers(i.e. the indifference points of decision making).

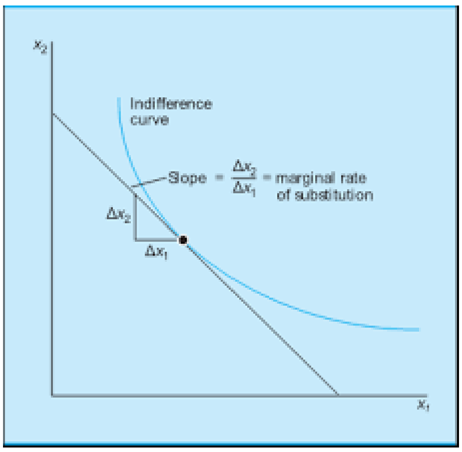

Figure 1: The Marginal rate of substitution of attributes of goods / alternatives

2-Materials and Methods

2-1-Indifference Curve

The points on the indifference curve show the combination of two goods (or decision-making options) that have the same desirability in terms of consumption [20]. These curves have a negative slope and are convex. They do not cross each other and, far away from the coordination origin, show a higher level of desirability [8]. On an indifference curve, the desirability of the consumption of various commodities (or decision-making options) is the same. In other words, indifference curves are the geometric locations of different combinations of two or more products (such as MCDM) that offer the same desirability to the person. These curves are continuous. So, the position of possibility of lexicography preferences will not be obtained [9], [38], [33].

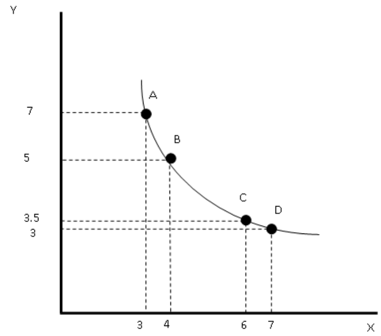

Figure 2: The graph of indifference curve

The utility function was proposed as a means to measure the value of the outcome of a decision, by Newman and Morgen Stern. The main idea of this approach is to maximize the utility of choosing a decision option. Despite the problems in determining the utility function, even in simple cases, it has the advantage that, if correctly identified, by solving the model, it can be assumed that the maximum satisfaction and desirability for the decision maker has been achieved. Also, the main idea Marginal Rate of Substitution(MRS) is to identify the rate of change in the consumption of a product versus the amount of loss of substitute goods in the event that the amount of final utility does not change. In the proposed method, it is possible to identify identical decision matrixes separately for each of the decision-making and decision-making indicators that so far has not existed and can improve the effectiveness of choices for supplier selection.

2-2- Meta-heuristic Algorithm

In the last 30years, a new kind of approximation algorithm has emerged.Its aim is to be a combination of innovative methods in bigger frameworks in order to explore efficient and effective research space. Today, these methods are named meta-heuristic methods [25]. So far, several meta-heuristic algorithms have been presented. These algorithms have proved more efficient for some problems.However, in some other problems,they face the issue of being close to the optimum answer. Most meta-heuristic methods are derived throughnatural and physical processes.

The optimization of the paper swarm optimization (PSO) algorithm, ant colony genetic algorithms (GAs), evolutionary algorithms, and simulation of refrigeration are examples of such algorithms[8]. The PSO method is a globally usedoptimization method that can deal with problems whose answer is a point or the surface in n-dimensional space. In such an environment, each paper has a position that defines the coordinates of the paper in the multi-dimensional search,which change with the motion of the paper over time and theposition of the particle. Here, xi (t) determines the position of the paper i at time t. Also,every paper needs to move in space ata certain speed. Here, vi (t) determines the velocity of the paper i at time t i. Byincreasing the speed with respect to the position of each particle, one can consider a new position for each particle. The position of updating the equation of the paper is given in the following equation.

$$\mathbf{x_i(t+1) = x_i(t) + v_i(t+1)}$$
$$\mathbf{x_i(t) \sim U(x_{min}, x_{max})}$$

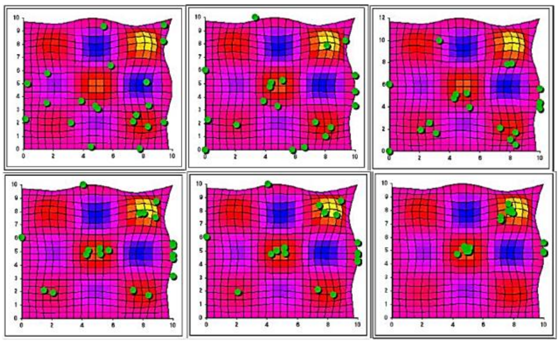

Figure 3: The particles move in a group

The best individual experience of a paper or the best met position by a paper yi (pbest) is called. Papers can meet the best Achieved place by the whole group that this position is called yi (gbest). Today,GAs are used to solvenumerousproblems in thefields of engineering andsocial science. A GA can be used for restricted and non-restricted problems [36].For standard optimization problems, this is the only way to get an answer. Also, it can be used for linear and nonlinear problems, as well as inprobable planning that involvesrandom variables and adegree of uncertainty [40]. In addition, combinatorial optimization problems that include different problems about computer sciencehavebeen used [8]. GA has provided apowerful method for the exploratory development of large-scale combinational optimization problems. The usual way of presenting chromosomes in GAs is in the form of binary strings [9].

2-3- Procedure of Research

Scientific research methods providethe only way to achieve acceptable and scientific achievements. The aim of the present study is to identify the parallel matrices with the primary matrices of decision-making.

Table 1: initial decision making matrix

criteria	standards	financial stability	company records	quality	customer satisfaction and history reputation	skilled manpower	company structure	technical equipments
Weight	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	C8
alter1	44.52	48.12	61.37	40.71	42.51	67.31	50.26	41.03
alter2	62.32	35.82	50.45	52.61	55.23	52.16	63.02	44.41
alter3	67.75	61.75	62.85	59.32	61.74	60.23	46.12	49.13
alter4	45.18	48.2	37.92	60.71	52.7	71.47	59.3	39.71
alter5	47.52	49.62	44.87	64.52	46.08	64.05	51.04	40.12
alter6	65.51	55.34	64.71	57.28	52.14	56.17	48.12	43.07
alter7	56.8	47.25	58.91	49.64	55.71	52.61	51.49	48.71
alter8	42.28	52.71	54.36	60.21	61.54	60.21	53.17	38.38
alter9	43.72	55.62	48.9	52.7	51.23	64.25	48.16	46.17
alter10	62.31	51.27	53.75	48.5	60.42	58.31	57.63	40.48

To achieve the intended aim that has been accomplished as a case study regarding the evaluation of contractors of a gas company in Zanjan province, first, a primary matrix of decision-making involving10 company experts was prepared according to eight criteria (C1: standards, C2:financial stability, C3:company records, C4:quality, C5:customer satisfaction and Good record, C6:skilled manpower, C7:company structure, C8: technical equipment).This was prepared and rated separatelythrough the two methods of AHP and TOPSIS. To identify the parallel matrices, the PSO and GA techniques were used.

Consider that the number of programs running was RUN = 10, and each run was done in two ways and two different techniques were used. In general, 40 different matrices were produced.

Among them, according to the fitness function,zeroparallel matrices with the primary matrix have been identified. In the final stage, bycomparing andmatching the parallel matrices and facilities of the organization, an appropriateoption shall be selected that is more consistent with the resources and guidelines of the organization.

Ranking matrix by TOPSIS
Rank = 1 Alter = 3 Score = 0.13885
Rank = 2 Alter = 6 Score = 0.12422
Rank = 3 Alter = 10 Score = 0.10622
Rank = 4 Alter = 8 Score = 0.10137
Rank = 5 Alter = 7 Score = 0.094438
Rank = 6 Alter = 5 Score = 0.092619
Rank = 7 Alter = 9 Score = 0.09074
Rank = 8 Alter = 4 Score = 0.089866
Rank = 9 Alter = 2 Score = 0.084263
Rank = 10 Alter = 1 Score = 0.07741
Ranking matrix by AHP
Rank = 1 Alter = 3 Score = 0.11111
Rank = 2 Alter = 6 Score = 0.10501
Rank = 3 Alter = 10 Score = 0.10173
Rank = 4 Alter = 8 Score = 0.099919
Rank = 5 Alter = 7 Score = 0.099179
Rank = 6 Alter = 4 Score = 0.098012
Rank = 7 Alter = 2 Score = 0.097471
Rank = 8 Alter = 9 Score = 0.097327
Rank = 9 Alter = 5 Score = 0.097023
Rank = 10 Alter = 1 Score = 0.093211

2-4- Data

The primary matrix of the company contractors' evaluation decision-making based on the company's criteria and in thepresence of experts has been presented below and ranked,using AHP and TOPSIS in MATLABsoftware.

3-Discussion& Results

In this line of research regarding the ability of meta-heuristic algorithms,PSO and GAshave been used through the AHP and TOPSIS methodsin MATLAB software to generate 10 parallel matrices(RUN =10).These have been implemented and their results are given in Table 2 and Graph 2.According to the above table,the best fitness = 0;that is as its parallel matrix with initial decision making matrix. These matrices have been presented in Table 3.

Considering that one of the objectives of this research is the development of scientific issues in the field of multi-criteria decision making, the results of this research are in line with Salati&Makoui research. With the difference that they sought to provide a value function (utility) using the UTA method, the present research seeks to identify the points of indifference in decision-making issues. Since, in the indifference curves, all points on each curve provide the same utility with different constituents. Each Parallel Matrixes represents a point on the indifference curve. Given that most of the decisions and strategies adopted by organizations are in the process of implementation, the identification of different options for decision making increases the flexibility of the organization in the implementation phase and increases the chance of realizing decisions and strategies. The results of this study are closely related to Xiaohan et al. The distinction of the present study is to find the final rate of succession between the criteria and to find indifferent points and to use particle swarm algorithms and genetic algorithms and information on hospital purchases have been the main constraints of this study. Therefore, it is suggested that the calculation of the final rate of succession between several commodities / methods be simultaneously studied.

Table 3: - output status matrixes produced with GA and PSO techniques&TOPSIS

Table 4: - output status matrixes produced with GA and PSO techniques&AHP

PSO	GA	N
Iter = 100 BEST = 4 MEAN = 4.66 Best Fitness = 4	Iter = 100 BEST = 6 Best Fitness = 6	1
Iter = 100 BEST = 2 MEAN = 3.06 Best Fitness = 2	Iter = 100 BEST = 4 Best Fitness = 4	2
Iter = 7 BEST = 0 MEAN = 22.24 Best Fitness = 0	Iter = 100 BEST = 16 Best Fitness = 16	3

TOPSIS		RUN
PSO	GA	
Iter = 100 BEST = 4 MEAN = 4.66 Best Fitness = 4	Iter = 100 BEST = 6 Best Fitness = 6	1
Iter = 100 BEST = 2 MEAN = 3.06 Best Fitness = 2	Iter = 100 BEST = 4 Best Fitness = 4	2
Iter = 7 BEST = 0 MEAN = 22.24 Best Fitness = 0	Iter = 100 BEST = 16 Best Fitness = 16	3
Iter = 100 BEST = 4 MEAN = 4.36 Best Fitness = 4	Iter = 100 BEST = 24 Best Fitness = 24	4
Iter = 10 BEST = 0 MEAN = 27.86 Best Fitness = 0	Iter = 100 BEST = 22 Best Fitness = 22	5
Iter = 100 BEST = 6 MEAN = 8.2 Best Fitness = 6	Iter = 100 BEST = 20 Best Fitness = 20	6
Iter = 100 BEST = 6 MEAN = 8.34 Best Fitness = 6	Iter = 100 BEST = 18 Best Fitness = 18	7
Iter = 3 BEST = 0 MEAN = 40.78 Best Fitness = 0	Iter = 100 BEST = 4 Best Fitness = 4	8
Iter = 100 BEST = 8 MEAN = 8.28 Best Fitness = 8	Iter = 100 BEST = 20 Best Fitness = 20	9
Iter = 100 BEST = 2 MEAN = 2.34 Best Fitness = 2	Iter = 100 BEST = 8 Best Fitness = 8	10

RUN	AHP	
	PSO	GA
1	Iter = 100 BEST = 2 MEAN = 2.92 Best Fitness = 2	Iter = 100 BEST = 6 Best Fitness = 6
2	Iter = 100 BEST = 6 MEAN = 10 Best Fitness = 6	Iter = 100 BEST = 6 Best Fitness = 6
3	Iter = 100 BEST = 2 MEAN = 2.18 Best Fitness = 2	Iter = 100 BEST = 22 Best Fitness = 22
4	Iter = 100 BEST = 2 MEAN = 11.94 Best Fitness = 2	Iter = 100 BEST = 26 Best Fitness = 26
5	Iter = 4 BEST = 0 MEAN = 50.02 Best Fitness = 0	Iter = 100 BEST = 14 Best Fitness = 14
6	Iter = 11 BEST = 0 MEAN = 44.7 Best Fitness = 0	Iter = 100 BEST = 12 Best Fitness = 12
7	Iter = 100 BEST = 6 MEAN = 9.66 Best Fitness = 6	Iter = 100 BEST = 30 Best Fitness = 30
8	Iter = 100 BEST = 4 MEAN = 4 Best Fitness = 4	Iter = 100 BEST = 10 Best Fitness = 10
9	Iter = 45 BEST = 0 MEAN = 10.5 Best Fitness = 0	Iter = 100 BEST = 24 Best Fitness = 24
10	Iter = 100 BEST = 4 MEAN = 5.6 Best Fitness = 4	Iter = 100 BEST = 18 Best Fitness = 18

Table 5: Indifference point initial decision making matrix

Indifference point 1:OUT PUT 3 - TOPSIS- PSO

وزن	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	c8
Ater1	4	0	0	82	57	50	0	0
Ater2	34	0	0	88	0	46	78	18
Ater3	118	124	30	119	0	118	93	0
Ater4	77	6	0	6	41	100	0	3
Ater5	48	0	43	130	0	13	103	81
Ater6	19	74	126	80	79	8	14	41
Ater7	86	58	25	100	10	0	94	30
Ater8	83	63	0	70	108	31	26	77
Ater9	40	0	35	106	0	85	64	93
Ater10	81	2	108	62	24	79	89	81

Indifference point 2:OUT PUT 5 - TOPSIS- PSO

وزن	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	c8
Ater1	42	0	0	40	0	0	7	12
Ater2	73	2	0	13	103	18	127	51
Ater3	26	122	123	91	99	105	66	87
Ater4	75	0	52	122	5	12	91	12
Ater5	20	66	8	74	22	61	59	77
Ater6	132	55	130	0	0	113	97	52
Ater7	39	49	29	100	112	0	103	98
Ater8	85	47	35	97	0	120	92	16
Ater9	20	69	18	83	103	52	0	31
Ater10	99	12	99	97	101	51	116	61

Indifference point 3:OUT PUT 8 - TOPSIS- PSO

وزن	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	c8
alter1	90	0	50	8	28	0	40	4
alter2	0	72	61	0	32	32	0	63
alter3	109	124	33	119	9	105	19	96
alter4	91	97	66	0	0	143	0	0
alter5	46	90	90	21	50	32	103	0
alter6	132	27	9	74	105	0	97	82
alter7	85	95	84	0	112	19	83	0
alter8	85	0	87	121	0	115	69	0
alter9	83	70	67	0	0	129	97	0
alter10	0	75	8	80	121	117	116	0

Indifference point 4: OUT PUT 5- AHP-PSO

وزن	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	c8
Ater1	50	9	0	0	86	135	0	27
Ater2	70	10	95	2	53	36	59	43
Ater3	136	124	13	110	124	106	38	78
Ater4	48	39	76	37	15	30	43	47
Ater5	87	20	28	0	34	124	24	0
Ater6	132	0	126	115	87	99	83	87
Ater7	40	95	118	19	0	66	0	62
Ater8	0	60	109	55	36	121	54	0
Ater9	50	17	0	38	0	0	97	71
Ater10	125	58	0	40	53	65	116	73

Indifference point 5:OUT PUT 6 - AHP-PSO

وزن	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	c8
alter1	56	9	0	82	0	0	101	83
alter2	23	72	0	0	111	0	95	89
alter3	136	105	7	119	95	121	93	7
alter4	82	26	62	0	0	143	119	80
alter5	0	28	32	85	0	99	0	81
alter6	132	20	130	0	0	113	97	67
alter7	0	95	0	100	112	13	103	0
alter8	0	0	109	121	0	73	107	77
alter9	45	0	0	32	103	82	97	93
alter10	125	0	50	86	75	117	116	13

Indifference point 6:OUT PUT 9 - AHP-PSO

وزن	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
	c1	c2	c3	c4	c5	c6	c7	c8
alter1	0	34	0	0	86	93	1	30
alter2	1	20	101	76	3	3	0	17
alter3	136	110	92	20	95	99	1	99
alter4	37	35	41	16	74	127	0	5
alter5	0	32	18	59	9	59	0	6
alter6	59	11	114	52	89	87	79	63
alter7	97	7	8	78	28	43	103	20
alter8	33	98	109	0	79	13	94	31
alter9	5	1	94	9	37	44	0	93
alter10	45	39	61	56	121	49	113	0

Table 6: alter 3 position in output results of Indifference point matrixes

Weight	0.125	0.15	0.125	0.15	0.1	0.125	0.125	0.1
criteria	c1	c2	c3	c4	c5	c6	c7	C8
TOPSIS- PSO OUT PUT 3-	118	124	30	119	0	118	93	0
OUT PUT 5-TOPSIS-PSO	26	122	123	91	99	105	66	87
TOPSIS- OUT PSO PUT 8-	109	124	33	119	9	105	19	96
AHP-PSO OUT PUT 5-	136	124	13	110	124	106	38	78
AHP-PSO OUT PUT 6-	136	105	7	119	95	121	93	7
AHP-PSO OUT PUT 9-	136	110	92	20	95	99	1	99

Conclusion

It is possible to substitute C7:company structure for the C6:skilled manpower and C8: technical equipment and C2:financial stability . Based on the out put 5-AHP-PSO, it is suggested that the third supplier, which ranked first in comparison with other suppliers, is recommended by increasing the combination of skilled manpower and appropriate technical equipment against the company's structure overhead criterion. In other words, there is the possibility of succession between the criteria. By identifying the above scenario, Zanjan province Gas Company can have more flexibility than the past in selecting suppliers. The lack of scientific resources regarding the calculation of the final rate of succession of several commodities / methods and the combination of the model of indifference curves and the multi-criteria curriculum and the conservatism of experts in providing quantitative information on hospital purchases have been the main constraints of this study. Therefore, it is suggested that the calculation of the final rate of succession between several commodities / methods be simultaneously studied.

References

1. ali hedari boyoki, t& ,.khademi zareh, h.(2016) .development DEA method to clustering credit customers Banks .Modeling in Engineering.

2. alvani, s.(1995) .Decision-making and public policy.tehran: samt.

3. amiri, m., rahimi, m& ,.tabli, h.(2013) .New method for solving multi-criteria decision . Journal of Industrial Management Studies,45-65.

4. asgharpour, m. j .(2003) .multiple criteria decision making.tehran: tehran university.

5. azar, a., mahdavi rad, a. r& ,.mosakhani, m .(2015) .Design model combines data mining and multi-criteria decision (Case Study Database subsidies Statistical Center of Iran .(Journal of Operational Research and Its Applications (Applied Mathematics) - Lahijan Azad University- ,95-111.

6. baradaran hoseni, m .(2011) .Application of genetic algorithms in the Computer-aided process planning (CAPP) various industrial environments.tehran: islamic azad university.

7. behnamiyan, j& ,.fatemei ghomi, s. t .(2011) . Providing hybrid algorithm based on PSO and hyper-heuristic method for scheduling factories distributed virtual alliance . Research of Engineering in Manufacturing Systems ,1-11.

8. blum, c& ,.roil, a.(2003) .Metaheuristics in combinatorial optimization .Overview and conceptual comparison ,268-311.

9. blum, c& ,.roil, a .(2008) .Hybrid Metaheuristics.berlin: springer-verlag.145-160

10. borenstein, y& ,.poli, r.(2006) .structure and metaheuristics .8th annual conference on genetic and evolutionary computation.washington.

11. burke, K. E& ,.Kendall, G .(2005) . Introductory Tutorials in Optimization and Decision Support Techniques.new york: springer.68-84

12. Denpontin, M., Mascapla, H& ,.Spronk, J.(1998) .A user oriented listing of MCDM . Revue Beige de Researche Operationelle 23 , 3-11.

13. ebrahimi, b., rahmani, m& ,.khakzarbfrobi, m .(2016) .New models of data envelopment analysis to determine the most efficient units of decision-making with regard to inaccurate data .Research of Engineering in Manufacturing Systems,139-148.

14. Ferland, A. J., lavoie, A& ,.Hertz, A.(1996) . An Object-Oriented Methodology for Solving Assignment-Type Problems with Neighborhood Search Technique .operation research44(2 ,(347-359)

15. ghasemeh, r., jamali, g. r& ,.karimi asl, e.(2016) .Large scale analysis of supply chain approach in the cement industry through a combination of multiple criteria

decision making techniques .Industrial Management Tehran University,813-836.

16. Gonzalez, F. T.(2007) .Handbook of Approximation Algorithms and Metaheuristics.Boca Raton: Chapman and Hall.

17. Hendrix, T. M& ,.G-Toth, B.(2010) . Goodness of optimization algorithms Introduction to Nonlinear and Global Optimization.new York: Springer.

18. hoseni, z& ,.kazemi, m.(2016) .Compare the results of direct extraction utility function and a linear-approximate estimates in solving multi-criteria decision-making models . Journal of Operational Research and Its Applications (Applied Mathematics) - Lahijan Azad University,15-28.

19. Intriligator, M.(1998) .Econometric Models,Techniques andApplications.NewJersey: Hall,Inc.

20. james, A& ,.estoner, E.(2001) . management.tehran: calturealre search publication.87-96

21. khatami firoozabadi, a.(2010) .Providing decision support system in regard to selection and evaluation of suppliers using UTA .Management development.

22. Liu, J.(1999) .The impact of neighbourhood size on the process of simulated annealing: Computational experiments on the flowshop scheduling problem .computers&Industrial Engineering37(1-2,(285-288)).

23. LV, P., Yuan, L& ,.Zhang, J.(2009) .Cloud theory-based simulated annealing algorithm and application .Engineering Applications of Artificial Intelligence,22,742-749.

24. mahmoodi tehrani, a& ,.kianpour, m.(2015) . optimized geometric partial differential equations with random data .Journal of Operational Research and Its Applications (Applied Mathematics,(37-59.

25. Metaheuristics.(2011)www.metaheuristic.com/metaheuristic_optimization.php.

26. mohamad moradi, a& ,.akhtar kavan, m . (2010) .Multi-criteria decision analysis methodologies, models.armanshar.

27. mohamadi ranjbarani, d., salimi fard, k ,. &yosefi, s.(2015) .Check the performance of the most common optimization techniques, multi-criteria decision approach .Journal of Operational Research and Its Applications (Applied Mathematics) - Lahijan Azad University,65-83.

28. momeni, m.(2011) .new topics in operations research.tehran: bakhtar.45-61

29. pasha, y., mostafaiei, h. r., khlaj, m ,. &khalaj, f.(2013) .Calculate the Uncertainty Interval Based on Entropy and dempster shafer theory of evidence .International Journal of Industrial Engineering&Production Management,216-223.

30. radfar, r.(2006) .presented a dynamic model for organizational planning solutions based Network-based internal issues.tehran: Science and Research Branch islamic azad university.

31. radfar, r& ,.kiyani, n.(2015) .Identify and ranking the factors affecting the efficiency of using by DEMATEL .productivity journal,111-130.

32. rezaiyan, a.(1993) .perncipal management.tehran: samt.95-117

33. salati, f& ,.makoei, a.(2014) .Providing utility function prioritize research projects using research and development centers by UTA .Industrial Management Studies,19-31.

34. shafiei nikabadi, m., farajpour, h ,. &eftekhari, h.(2016) .applied combination hybrid approachFA,AHP,TOPSISfor the selection and ranking strategies convenient maintenance and repairs .Industrial Management Studies.

35. shahbazi, L.(2016) .At the same time optimize the planning problem-labor-service equipment by use particle swarm algorithm.zanjan: islamic azad university zanjan branch.

36. Talibi, G. E.(2009) .METAHEURISTICS: FROM DESIGN TO IMPLEMENTATION.147-165

37. tavakoli moghadam, r& ,.eslami, s.(2007) . Presents a new mathematical model for staffing schedule and solve it using genetic algorithms .Journal of Industrial Engineering,21-31.-

38. tavakoli, a& ,.nafar, m.(1991) .Mathematical Economics.Esfahan: Esfahan university.245-278

39. Wang, X.(2010) .Solving Six-Hump Camel Back Function Optimization Problem by Using Thermodynamics Evolutionary Algorithm.

40. Weise, T.(2007) .Global Optimization Algorithm: Theory and Application. 124-135

41. Xin, Y.(1991) .Simulated Annealing with Extended Neighborhood .International Journal of Computer Mathematics,40(3-4 ,(169-189)).

42. yaghini, m& ,.akhvan kazemzadeh, m. r.(2012) .metaheuristic optimization algorithms.tehran: jahad amirkabir university.

43. Xiaohan Yu, SuojuanZh, XianglinL,Xiuli Q. ELECTRE Methods in Prioritized MCDM Environment. Information Sciences Journal. January 2018;424: 301-316https://doi.org/10.1016/j.ins.2017.09.061