Journal of Research Administration
Society of Research Administrators International

PRIORITIZATION OF FACTORS FOR IMPROVEMENT OF HEALTHCARE QUALITY

J.V. Bhanutej [1], V.V.S. Kesava Rao [2]

[1] Department of Mechanical Engineering, Anil Neerukonda Institute of Technology and Sciences, Andhra Pradesh, India

[2] Department of Mechanical Engineering, Faculty of Engineering, College of Engineering, Andhra University, Andhra Pradesh, India

ABSTRACT

Continuous improvement of health care systems is a critical global priority to ensure equitable access, quality care, and optimal health outcomes for populations. Enhancing health care delivery requires an informed and systematic approach to prioritize factors that have the greatest potential for improvement. Prioritizing factors for the improvement of health care requires a comprehensive and multi-criteria decision making approach. This paper aims to provide a comparative analysis of three popular prioritization methods: CRITIC (CRiteria Importance Through Inter-criteria Correlation method), Entropy, and MEREC (MEthod based on the Removal Effects of Criteria).Integrating these prioritization methods into healthcare decision-making processes can facilitate informed resource allocation, drive impactful improvements, and contribute to enhancing healthcare outcomes.

Keywords - Healthcare, Entropy, CRITIC, MEREC.

1. INTRODUCTION

Healthcare improvement requires a comprehensive understanding of the multifaceted factors influencing the quality, accessibility, and efficiency of care. These factors can include financial resources, workforce capacity, technology adoption, patient engagement, and the overall healthcare delivery system. Prioritizing these factors allows decision-makers to identify areas where interventions can have the greatest impact, leading to more effective resource allocation and targeted improvement strategies.

Zhou, Rongxi et al (2008) made a survey on applications of entropy and research directions are discussed in detail. Eiseman et al (2014) introduced information theory's mathematical methods for assessing diagnostic uncertainty and test efficacy in various circumstances. VUJIČIĆ et al (2017) adopted Entropy and CRITIC, together with MOORA and SAW for evaluation and selection of air conditioner

Mališa Žižović et al (2020) proposed CRITIC-M method which is a modified method of CRITIC method for improving decision making and illustrated with two numerical examples. Ali and Khorsand (2020) made a literature on MCDM applications to health care issues is reviewed in this research. This study adds to the body of knowledge already available on healthcare and MCDM. Miao et al (2020) developed evaluation framework using DEMATEL and evaluation entropy to assess the treatment and diagnosis of hypertension in various medical institutions. Yuxin Zhu et al

© 2023 The Authors

(2020) demonstrated EWM's decision-making rationality with a case study on. selection on water supply location. EWM only considers the numerical discrimination degree of the index and ignores rank discrimination. Aihua Li et al (2020) developed Service quality index system based on SERVQUAL concept and suggested Fuzzy hierarchical entropy method to determine relative weights of criteria. The authors evaluated service quality of the senior care station through fuzzy comprehensive evaluation model.

Raman kumar et al (2021) examined the use of entropy weights in machining operations to classify and interpret both persistent and new problems. Ananth Rau et al (2021) distance correlation-based CRITIC (D-CRITIC) approach to know the importance of five smartphone characteristics for evaluation of these phones. Xindong et al (2021) developed an algorithm using CoCoSo (Combined Compromise Solution), an interval-valued fuzzy soft decision-making method and CRITIC method for evaluation of the healthcare management industry. Mehdi et al (2021) introduced MEREC (MEthod based on the Removal Effects of Criteria) to determine criteria' objective weights in a numerical example on MCDM methods and made comparative analysis with CRITIC, Entropy and Standard deviation methods. Trung and Thinh (2021) adopted Entropy and the MEREC were used to determine the weights for the criteria namely surface roughness and material removal rate in machining operations.

Amar A et al (2022) gathered standards and weighted using an entropy method to assess various hospitals' departments. The authors measured layout score through adjacent algorithm. Shen Y, and Liao K (2022) combined the entropy weight method with the AHP approach to create a comprehensive index weighting method that quantitatively assesses the key hazards in cold food supply chain. Khan et al (2022) examined the use of multicriteria decision analysis (MCDA) techniques in many facets of health care, with a focus on how different MCDA techniques are used to distinct healthcare decision-making issues. Mukhametzyanov (2022) determined the weights of criteria based on formal processing of the decision matrix (Entropy, CRITIC, Standard deviation) for MCDM problems. The author opined that comprehensive analysis is required to show the rationality of all objective methods for evaluating the criteria weights for MCDM tasks. Abeer Hadi and Mahmood (2022) found the best alternatives site for hospital location for COVID-19 infected patients through MEREC and TOPSIS. In the study, weights of the criteria for site selection namely: distance to industrial sites, accessibility via airports, distance from residential areas and transportation/accessibility are determined through MEREC method

Nuh Keles (2023) applied modifications to MEREC method by considering Geometric and harmonic mean from multiplicative functions and illustrated with numerical examples. The results are compared with the results of the CRITIC method are very close to each other. Banik et al (2023) evaluated best crop with optimal agricultural based scenario by considering opinions of group of experts by integrating GRA and MEREC method under pentagonal neutrosophic environment.

© 2023The Authors

From the literature review it is observed that there are limited applications of CRITIC, Entropy and MEREC methods in healthcare management. There is a lack of comparative studies that directly compare the effectiveness and suitability of these methods. Comparative studies would provide insights into the strengths, weaknesses, and appropriate contexts for each method. Hence this study is made which will add literature in healthcare studies in the area of MCDM methods

2. METHODS FOR PRIORITIZATION OF FACTORS FOR THE IMPROVEMENT OF HEALTHCARE SERVICE QUALITY

Prioritization of factors for healthcare improvement plays a pivotal role in resource allocation and effective decision-making. The CRITIC, Entropy, and MEREC methods offer distinct approaches to prioritize factors based on intercriteria correlations, entropy-based variability, and expert opinions, respectively. By employing these methods, healthcare organizations and policymakers can identify the most critical areas for improvement, optimize resource allocation, and drive meaningful changes to enhance the overall quality and effectiveness of healthcare delivery. The proposed methods are described briefly.

2.1 CRITIC METHOD: The CRITIC method offers a systematic and objective approach for prioritizing factors in healthcare improvement. By considering intercriteria correlations, decision-makers can identify the most influential factors that contribute to better healthcare outcomes. The method is explained in the following steps.

Step 1: The decision matrix *X* is formed. It shows the performance of different alternatives with respect to various criteria.

$$X = \left[x_{ij}\right]_{m\times n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (i = 1,2\ldots,m \text{ and } j = 1,2,\ldots,n) \qquad (1)$$

x_{ij} presents the performance value of *i*th alternative on *j*th criterion.

Firstly, it is assumed that there is a set of judgments from alternatives on the importance of the given criteria. In this study, Measurement Items of HEALTHQUAL are considered as criteria and patients are considered as alternatives. The feasible alternatives Ai (i = 1,2,…,m) and n evaluation criteria Cj (j = 1,2,…,n)

Step 2: Decision matrix is normalized using the following equation:

$$x_{ij}^{*} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \qquad i = 1, 2,\ldots,m \text{ and } j = 1, 2,\ldots,n \qquad (2)$$

x_{ij}^{*} is the normalized performance value of *i*th alternative on *j*th criterion. Here it should be noted that normalization does not take into account the type of criteria.

© 2023The Authors

Step 3: While determining the criteria weights, both standard deviation of the criterion and its correlation between other criteria are included. In this regard, the weight of the *j*th criterion (w_j) is obtained as:

$$w_j = \frac{C_j}{\sum_{j=1}^{n} C_j} \quad (3)$$

where C_j is the quantity of information contained in *j*th criterion determined as:

$$C_j = \sigma_j \sum_{j'=1}^{n} \left(1 - r_{jj'}\right) \quad (4)$$

where σ_j is standard deviation of the *j*th criterion and $r_{jj'}$ is the correlation coefficient between the two criteria. It can be concluded that this method gives the higher weight to the criterion which has high standard deviation and low correlation with other criteria (Aznar Bellver et al., 2011). Namely higher value of C_j means that a greater amount of information is obtained from the given criterion so the relative significance of the criterion for the decision making problem is higher.

2.2 MEREC METHOD: The MEREC method offers a valuable approach for prioritizing factors in healthcare improvement initiatives. By leveraging the expertise of multiple experts and considering their rankings, the method provides a comprehensive understanding of factors' importance in healthcare improvement. The MEREC method is explained in the following steps.

Step 1: Construct the decision matrix. A decision matrix is constructed in this step, which shows each alternative's ratings or values concerning each criterion.

Step 2: Normalize the decision matrix (N). In this step, a simple linear normalization is used to scale the elements of the decision-matrix. The elements of the normalized matrix are denoted by n x ij. If B shows the set of beneficial criteria, and H represents the set of non-beneficial criteria, we can utilize the following equation for normalization:

$$n_{ij}^{x} = \begin{cases} \dfrac{\min\limits_{k} x_{kj}}{x_{ij}} & if \quad j \in \mathcal{B} \\ \dfrac{x_{ij}}{\max\limits_{k} x_{kj}} & if \quad j \in \mathcal{H} \end{cases}$$

Step 3: Calculate the overall performance of the alternatives (Si). A logarithmic measure with equal criteria weights is applied to obtain alternatives' overall performances in this step. The following equation is used for this calculation

$$S_i = ln\left(1 + \left(\frac{1}{m}\sum_{j}\left|ln\left(n_{ij}^{x}\right)\right|\right)\right)$$

Step 4: Calculate the performance of the alternatives by removing each criterion. The following equation is used for the calculations of this step

© 2023The Authors

$$S'_{ij} = ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j}|ln(n^{x}_{ik})|\right)\right)$$

Step 5: Compute the summation of absolute deviations. In this step, the removal effect of the each criterion based on the values obtained from Step 3 and Step 4 is calculated using the following formula

$$E_j = \sum_{i}\left|S'_{ij} - S_i\right|$$

Step 6: Determine the final weights of the criteria. In this step, each criterion's objective weight is calculated using the removal effects (Ej) of Step 5 from the following equation

$$w_j = \frac{E_j}{\sum_k E_k}$$

2.3 ENTROPY METHOD: The Entropy method offers a systematic and objective approach for prioritizing factors in healthcare improvement initiatives. By quantifying the variability and importance of each criterion, decision-makers can identify and focus on factors that contribute the most to reducing uncertainty and improving healthcare outcomes. The methodology is explained in the following steps.

Step1: Formulate the decision matrix: Decision matrix is formulated by considering the stake holders as alternatives and factors of healthcare quality as criteria.

Step 2: Decision matrix is normalized using the following equation:

$$x^{*}_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \qquad i = 1, 2, \ldots, m \text{ and } j = 1, 2, \ldots, n \qquad (2)$$

x^{*}_{ij} is the normalized performance value of *i*th alternative on *j*th criterion. Here it should be noted that normalization does not take into account the type of criteria.

Step 3: Calculate the proportion of the kth sample of the j th indicator in the i th group

$$p_{ijk} = \frac{x'_{ijk}}{\sum_{k=1}^{a} x'_{ijk}}$$

Step 4: Calculate the entropy value of the j th indicator in the i th group

$$e_{ij} = -\frac{\sum_{k=1}^{a} p_{ijk} \cdot \ln p_{ijk}}{\ln a}$$

Step 5: Calculate the entropy weight of the j th indicator in the i th group.

© 2023The Authors

$$\beta_{ij} = \frac{1-e_{ij}}{\sum_{i=1}^{n}(1-e_{ij})}$$

3. CASE STUDY

Data in the study made in literature (Bhanutej and V.V.S. Kesava Rao, 2023) is considered to build healthcare service quality (HEALTHQUAL) measuring items are considered in the study to prioritize these healthcare quality items through the proposed method. The validated consturcts and their measuring items are presented below.

Construct	Measurement Variable
Empathy	Polite attitudes of employees (EM1)
	Explaining the details (EM2)
	Listen to the patient (EM3)
	Understand and consider the patient's situation (EM4)
	A sense of closeness and friendliness (EM5)
	Hospital knows what the patient wants (EM6)
	Hospital understands the patient's problems as empathy (EM7)
Tangibles	Degree of securing advanced medical equipment (TA1)
	Degree of securing medical staff with advanced skills and knowledge
	Degree of convenient facilities (TA3)
	Degree of cleanliness of employee uniforms (TA4)
	Overall cleanliness of the hospital (TA5)
Safety	Degree of a comfortable and safe environment for receiving treatment (SA1)
	Degree of the feeling that doctors would not make misdiagnosis (SA2)
	Degree of the feeling that nurses would not make mistakes (SA3)
	Degree of confidence about the medical proficiency of this hospital (SA4)
	Degree of a hospital environment that is safe from infection (SA5)
	Degree of a comfortable and safe environment for patients (SA6)
Efficiency	Attitudes about not using unnecessary medication(EF1)
	Degree of efforts for proving appropriate treatment methods (EF2)
	Reasonable medical expenses(EF3)
	Appropriateness of cost for medical services provided (EF4)
	Degree of convenience for treatment procedures (EF5)
	Degree of efforts for reducing unnecessary procedures (EF6)
Degree of Improvement	Appropriateness of care service provided (DI1)
	Recognition and efforts for the best treatment by the medical Staff (DI2)
	Improvement in medical condition as a result of efforts and treatment (DI3)
	Degree of improved patient condition after using this hospital care(DI4)
	Degree of explanations to the patient to prevent related dsease (D15)
	Degree of efforts and willingness to prevent disease (DI6)
	Improvement of disease through this hospital's treatment (DI7)
	Degrees of disease prevention to communities (DI8)
Operational Performance	Availability of Beds (OP1)
	Waiting time of the Patients(OP2)
	Loyalty of the patients(OP3)
	Length of Stay (OP4)
	Cost of Treatment (OP5)

© 2023The Authors

The data on the measuring items are presented below

Table 2 General Statistics of the Criteria

Criteria	Mean	Std	Cronbach Alpha	Criteria	Mean	Std	Cronbach Alpha
EM1	3.3571	1.2685	0.7808	EF1	3.4150	1.3159	0.7643
EM2	3.4354	1.2561	0.7788	EF2	3.5102	1.1965	0.7716
EM3	3.2143	1.2685	0.7790	EF3	3.4592	1.2919	0.7806
EM4	3.5102	1.3082	0.7907	EF4	3.5238	1.1616	0.7693
EM5	3.3571	1.3544	0.7900	EF5	3.4966	1.2846	0.7798
EM6	3.3299	1.3180	0.7670	EF6	3.3469	1.2456	0.7624
EM7	3.3912	1.2719	0.7799	DI1	3.3469	1.3558	0.8264
TA1	3.3401	1.3972	0.6402	DI2	3.3571	1.2793	0.8213
TA2	3.5442	1.2758	0.6741	DI3	3.4388	1.2453	0.8211
TA3	3.5408	1.2892	0.6530	DI4	3.4014	1.3072	0.8156
TA4	3.5850	1.2818	0.6829	DI5	3.3605	1.3034	0.8150
TA5	3.3231	1.2803	0.6690	DI6	3.3844	1.2605	0.8207
SA1	3.3707	1.3019	0.7340	DI7	3.4592	1.2324	0.8201
SA2	3.2857	1.2692	0.7369	DI8	3.3469	1.3019	0.8185
SA3	3.4184	1.2926	0.7301	OP1	3.3435	1.3145	0.7326
SA4	3.2959	1.2574	0.7354	OP2	3.6429	1.2632	0.7232
SA5	3.3741	1.3204	0.7508	OP3	3.5986	1.3202	0.7077
SA6	3.4218	1.2954	0.7455	OP4	3.5102	1.3744	0.7403
				OP5	3.4014	1.2566	0.7783

4. RESULTS AND DISCUSSION

In this section, the results and discussions obtained from the application of the CRITIC, MEREC and Entropy methods to prioritize factors for the improvement of healthcare to a case study presented in section 3. The three methods were used to assess the importance of various factors influencing healthcare improvement initiatives.

4.1 CRITIC METHOD

4.1.1 Decision Matrix of criteria of Empathy: Decision matrix is presented as discussed in section 2.1

4.1.2 Normalized Decision Matrix of criteria of Empathy: Normalized Decision matrix is formulated as discussed in section 2.1

© 2023The Authors

4.1.3 Standard Deviation of Criteria of Empathy: Standard Deviation of the criteria of empathy are presented in the following table

Table 3: Standard Deviation (Empathy)

Criteria	EM1	EM2	EM3	EM4	EM5	EM6	EM7
STEDEV	0.3171	0.3140	0.3171	0.3271	0.3386	0.3295	0.3180

4.1.4: Correlation of Criteria of Empathy: Correlation of the criteria of empathy are presented in the following table

Table 4: Correlation (Empathy)

Criteria	EM1	EM2	EM3	EM4	EM5	EM6	EM7
EM1	1.000	0.358	0.374	0.303	0.331	0.511	0.364
EM2	0.358	1.000	0.436	0.319	0.348	0.437	0.389
EM3	0.374	0.436	1.000	0.360	0.402	0.345	0.362
EM4	0.303	0.319	0.360	1.000	0.330	0.411	0.312
EM5	0.331	0.348	0.402	0.330	1.000	0.316	0.337
EM6	0.511	0.437	0.345	0.411	0.316	1.000	0.497
EM7	0.364	0.389	0.362	0.312	0.337	0.497	1.000

4.1.4: Measure of Conflict of Criteria of Empathy: Measure of conflict of the criteria of empathy determined as discussed in section 2.1 and are presented in the following table

Table 5: Measure of Conflict (Empathy)

Criteria	E1	E2	E3	E4	E5	E6	E7
Measure of Conflict	3.759	3.713	3.721	3.965	3.936	3.483	3.739

4.1.5: Information Content of Criteria of Empathy: Information content of the criteria of empathy determined as discussed in section 2.1 and are presented in the following table

Table 6: Information Content (Empathy)

Criteria	E1	E2	E3	E4	E5	E6	E7
Information Content	1.192	1.166	1.180	1.297	1.333	1.148	1.189

© 2023The Authors

4.1.6: Relative weights of Criteria of Empathy: Relative weights of Criteria of empathy are determined as discussed in section 2.1 and are presented in the following table

Table 7: Relative weights of criteria (Empathy)

Criteria	E1	E2	E3	E4	E5	E6	E7
Relative Weight	0.1402	0.1371	0.1388	0.1525	0.1567	0.1350	0.1398

Similarly, the relative weights of the criteria of tangibles (TA), Safety (SA), Efficiency (EF), Degree of improvement (DI) and Operational Performance (OP) are determined and presented in the following table.

Table 8: Relative weights of the criteria (Critic Method)

Criteria	Rel.Wt	Criteria	Rel.Wt
EM1	0.1402	EF1	0.1701
EM2	0.1371	EF2	0.1599
EM3	0.1388	EF3	0.1795
EM4	0.1525	EF4	0.1531
EM5	0.1567	EF5	0.1781
EM6	0.1350	EF6	0.1594
EM7	0.1398	DI1	0.1385
TA1	0.2066	DI2	0.1259
TA2	0.1990	DI3	0.1224
TA3	0.1905	DI4	0.1228
TA4	0.2033	DI5	0.1218
TA5	0.2007	DI6	0.1234
SA1	0.1651	DI7	0.1200
SA2	0.1627	DI8	0.1252
SA3	0.1617	OP1	0.1941
SA4	0.1604	OP2	0.1968
SA5	0.1783	OP3	0.1948
SA6	0.1718	OP4	0.2177
		OP5	0.1967

4.2 MEREC METHOD

4.2.1 Decision matrix: Decision matrix is presented in table A.1 of Appendix A

© 2023The Authors

4.2.2: Normalize the decision matrix (N). Normalized decision matrix is determined as discussed in section 2.2 and is presented in Appendix B (Table B.1)

4.2.3 Overall performance of the alternatives (Si): Overall Performance of alternatives are determined as discussed in section 4.2 and are presented in the following table

Table 9: Overall performance of the alternatives

S.No	Si	S.No	Si	S.No	Si	S.No	Si	S.No	Si	S.No	Si
1	0.7892	51	0.7960	101	0.7198	151	0.4233	201	0.7324	251	0.9591
2	0.6354	52	0.6996	102	0.5877	152	0.6921	202	0.7124	252	0.9591
3	0.6626	53	0.6704	103	0.5211	153	0.8193	203	0.8233	253	0.9591
4	0.7503	54	0.6967	104	0.6626	154	0.7413	204	0.8697	254	0.9591
5	0.5928	55	0.8051	105	0.6539	155	0.7413	205	0.8697	255	0.9591
6	0.7934	56	0.7519	106	0.6102	156	0.7413	206	0.8697	256	0.9591
7	0.7079	57	0.5055	107	0.5020	157	0.7413	207	0.8697	257	0.9591
8	0.6539	58	0.7892	108	0.4964	158	0.7413	208	0.8697	258	0.9591
9	0.7908	59	0.6102	109	0.7050	159	0.7413	209	0.8697	259	0.9591
10	0.8754	60	0.3743	110	0.7404	160	0.7413	210	0.8697	260	0.9591
11	0.7041	61	0.7476	111	0.5783	161	0.7413	211	0.8697	261	0.9591
12	0.6950	62	0.6996	112	0.5365	162	0.7413	212	0.8697	262	0.9591
13	0.4134	63	0.6704	113	0.5960	163	0.7413	213	0.8697	263	0.9591
14	0.6865	64	0.7669	114	0.6539	164	0.7413	214	0.8697	264	0.9591
15	0.6412	65	0.7669	115	0.6996	165	0.7413	215	0.8697	265	0.9591
16	0.7555	66	0.5365	116	0.5783	166	0.7413	216	0.8697	266	0.9591
17	0.6950	67	0.4022	117	0.6243	167	0.7607	217	0.8697	267	0.9591
18	0.8152	68	0.6789	118	0.6548	168	0.7797	218	0.8697	268	0.9591
19	0.8118	69	0.7153	119	0.6548	169	0.7797	219	0.8697	269	0.9591
20	0.6323	70	0.6996	120	0.6548	170	0.7797	220	0.8697	270	0.9591
21	0.6789	71	0.5311	121	0.6548	171	0.7797	221	0.8830	271	0.9591
22	0.5549	72	0.7476	122	0.6548	172	0.7797	222	0.8830	272	0.2844
23	0.7503	73	0.7153	123	0.6845	173	0.7797	223	0.8830	273	0.6836
24	0.7041	74	0.6102	124	0.6845	174	0.7797	224	0.8961	274	0.8715
25	0.0000	75	0.6323	125	0.7413	175	0.7797	225	0.8961	275	0.6967
26	0.5365	76	0.5266	126	0.7413	176	0.8167	226	0.8961	276	0.3038
27	0.7555	77	0.5266	127	0.7413	177	0.8167	227	0.9090	277	0.5928
28	0.7041	78	0.5266	128	0.7413	178	0.8347	228	0.9090	278	0.8077
29	0.5549	79	0.5266	129	0.7413	179	0.8347	229	0.9090	279	0.6539
30	0.4233	80	0.5266	130	0.7413	180	0.8347	230	0.9090	280	0.6836
31	0.8397	81	0.5266	131	0.7413	181	0.8347	231	0.9218	281	0.5399
32	0.7789	82	0.5311	132	0.7413	182	0.8524	232	0.9218	282	0.4022
33	0.3038	83	0.5636	133	0.7413	183	0.8524	233	0.9218	283	0.5783
34	0.7124	84	0.4861	134	0.7413	184	0.8697	234	0.9344	284	0.6184
35	0.4768	85	0.5463	135	0.7413	185	0.8697	235	0.9468	285	0.5783
36	0.5928	86	0.5698	136	0.7413	186	0.8697	236	0.9468	286	0.5602
37	0.6626	87	0.7404	137	0.7413	187	0.8697	237	0.9591	287	0.5311
38	0.7476	88	0.6704	138	0.7413	188	0.8697	238	0.9591	288	0.8218
39	0.7476	89	0.8051	139	0.7413	189	0.8697	239	0.9591	289	0.5549
40	0.6836	90	0.5365	140	0.7413	190	0.8697	240	0.9591	290	0.6193
41	0.6674	91	0.4964	141	0.7413	191	0.8697	241	0.9591	291	0.5266
42	0.7704	92	0.7153	142	0.7413	192	0.8697	242	0.9591	292	0.6243
43	0.5636	93	0.4440	143	0.7413	193	0.8697	243	0.9591	293	0.7746
44	0.5211	94	0.6626	144	0.7413	194	0.8697	244	0.9591	294	0.7153
45	0.4663	95	0.6152	145	0.7413	195	0.8697	245	0.9591		
46	0.5698	96	0.7198	146	0.7413	196	0.8697	246	0.9591		
47	0.7669	97	0.6102	147	0.7413	197	0.8697	247	0.9591		
48	0.5928	98	0.5211	148	0.7413	198	0.8697	248	0.9591		
48	0.6152	99	0.6674	149	0.5731	199	0.5399	249	0.9591		
48	0.6323	100	0.6836	150	0.5452	200	0.5452	250	0.9591		

© 2023The Authors

4.2.4 Performance of the alternatives by removing each criterion: Performance of the alternatives by removing each criterion as discussed in section 2.2 and the values are presented in the following table

Table 10: Performance of the alternatives by removing each criterion

S.No	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7	S.No	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7	S.No	EM 1	EM 2	EM 3	EM 4	EM 5	EM 6	EM 7
1	0.679	0.715	0.695	0.789	0.715	0.679	0.679	51	0.687	0.702	0.687	0.687	0.796	0.750	0.687	101	0.601	0.720	0.670	0.601	0.618	0.670	0.618
2	0.635	0.506	0.635	0.506	0.635	0.525	0.506	52	0.618	0.578	0.649	0.700	0.596	0.649	0.578	102	0.588	0.451	0.496	0.496	0.531	0.588	0.496
3	0.663	0.663	0.578	0.578	0.536	0.555	0.555	53	0.545	0.618	0.670	0.545	0.618	0.564	0.618	103	0.423	0.521	0.521	0.374	0.521	0.396	0.461
4	0.652	0.635	0.750	0.635	0.750	0.635	0.635	54	0.697	0.593	0.615	0.593	0.646	0.615	0.593	104	0.610	0.578	0.536	0.610	0.578	0.663	0.555
5	0.593	0.502	0.502	0.477	0.536	0.536	0.536	55	0.712	0.732	0.712	0.760	0.712	0.732	0.697	105	0.654	0.527	0.601	0.601	0.601	0.545	0.545
6	0.720	0.700	0.684	0.793	0.700	0.700	0.684	56	0.704	0.654	0.654	0.637	0.752	0.654	0.654	106	0.496	0.610	0.610	0.555	0.521	0.521	0.477
7	0.627	0.627	0.588	0.627	0.588	0.708	0.658	57	0.506	0.356	0.506	0.444	0.356	0.444	0.506	107	0.440	0.440	0.502	0.374	0.440	0.502	0.402
8	0.545	0.601	0.545	0.654	0.527	0.654	0.545	58	0.715	0.679	0.789	0.679	0.679	0.715	0.695	108	0.346	0.496	0.396	0.434	0.496	0.396	0.496
9	0.717	0.697	0.697	0.697	0.745	0.697	0.717	59	0.521	0.477	0.496	0.610	0.610	0.555	0.521	109	0.624	0.602	0.655	0.624	0.624	0.655	0.624
10	0.775	0.789	0.808	0.775	0.775	0.808	0.789	60	0.304	0.260	0.374	0.304	0.374	0.374	0.304	110	0.692	0.663	0.692	0.663	0.641	0.663	0.624
11	0.601	0.601	0.704	0.704	0.601	0.601	0.583	61	0.632	0.632	0.748	0.700	0.649	0.670	0.649	111	0.461	0.461	0.440	0.486	0.578	0.578	0.578
12	0.573	0.613	0.613	0.573	0.573	0.695	0.695	62	0.578	0.578	0.618	0.700	0.649	0.649	0.596	112	0.536	0.440	0.440	0.477	0.413	0.536	0.477
13	0.413	0.346	0.346	0.304	0.413	0.413	0.304	63	0.670	0.545	0.670	0.618	0.545	0.564	0.564	113	0.540	0.596	0.461	0.596	0.461	0.540	0.506
14	0.564	0.564	0.582	0.687	0.635	0.564	0.687	64	0.720	0.654	0.670	0.670	0.654	0.767	0.670	114	0.601	0.545	0.654	0.545	0.654	0.527	0.545
15	0.555	0.588	0.555	0.555	0.588	0.641	0.512	65	0.654	0.767	0.654	0.670	0.670	0.720	0.670	115	0.596	0.700	0.700	0.596	0.618	0.578	0.578
16	0.658	0.679	0.679	0.679	0.756	0.641	0.641	66	0.477	0.413	0.440	0.536	0.440	0.477	0.536	116	0.486	0.521	0.521	0.578	0.578	0.461	0.440
17	0.573	0.613	0.695	0.613	0.573	0.573	0.695	67	0.334	0.402	0.402	0.334	0.402	0.334	0.260	117	0.570	0.536	0.570	0.536	0.536	0.570	0.570
18	0.708	0.743	0.770	0.743	0.708	0.708	0.743	68	0.555	0.596	0.573	0.679	0.596	0.679	0.555	118	0.570	0.570	0.602	0.570	0.570	0.602	0.602
19	0.767	0.720	0.704	0.720	0.720	0.704	0.767	69	0.596	0.666	0.635	0.715	0.596	0.666	0.596	119	0.570	0.570	0.602	0.570	0.570	0.602	0.602
20	0.502	0.578	0.521	0.545	0.632	0.578	0.578	70	0.596	0.649	0.578	0.700	0.578	0.649	0.618	120	0.570	0.570	0.602	0.570	0.570	0.602	0.602
21	0.596	0.679	0.679	0.555	0.596	0.573	0.555	71	0.531	0.531	0.434	0.434	0.531	0.386	0.434	121	0.570	0.570	0.602	0.570	0.570	0.602	0.602
22	0.496	0.413	0.555	0.461	0.555	0.496	0.461	72	0.632	0.649	0.748	0.632	0.700	0.670	0.649	122	0.570	0.570	0.602	0.570	0.570	0.602	0.602
23	0.635	0.635	0.635	0.635	0.750	0.652	0.750	73	0.666	0.596	0.596	0.635	0.715	0.666	0.596	123	0.602	0.602	0.602	0.602	0.602	0.633	0.633
24	0.601	0.601	0.704	0.654	0.654	0.601	0.583	74	0.610	0.555	0.477	0.610	0.521	0.496	0.521	124	0.602	0.602	0.602	0.602	0.602	0.633	0.633
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	0.545	0.521	0.632	0.521	0.502	0.578	0.632	125	0.664	0.664	0.664	0.664	0.664	0.664	0.664
26	0.440	0.536	0.440	0.413	0.536	0.477	0.477	76	0.466	0.466	0.466	0.466	0.466	0.466	0.466	126	0.664	0.664	0.664	0.664	0.664	0.664	0.664
27	0.641	0.756	0.679	0.679	0.679	0.641	0.658	77	0.466	0.466	0.466	0.466	0.466	0.466	0.466	127	0.664	0.664	0.664	0.664	0.664	0.664	0.664
28	0.601	0.601	0.654	0.654	0.654	0.583	0.654	78	0.466	0.466	0.466	0.466	0.466	0.466	0.466	128	0.664	0.664	0.664	0.664	0.664	0.664	0.664
29	0.496	0.461	0.496	0.555	0.413	0.461	0.555	79	0.466	0.466	0.466	0.466	0.466	0.466	0.466	129	0.664	0.664	0.664	0.664	0.664	0.664	0.664
30	0.260	0.356	0.423	0.356	0.356	0.423	0.423	80	0.466	0.466	0.466	0.466	0.466	0.466	0.466	130	0.664	0.664	0.664	0.664	0.664	0.664	0.664
31	0.750	0.735	0.750	0.735	0.840	0.735	0.735	81	0.466	0.466	0.466	0.466	0.466	0.466	0.466	131	0.664	0.664	0.664	0.664	0.664	0.664	0.664
32	0.732	0.704	0.684	0.684	0.732	0.667	0.684	82	0.531	0.434	0.434	0.386	0.531	0.531	0.434	132	0.664	0.664	0.664	0.664	0.664	0.664	0.664
33	0.181	0.304	0.228	0.304	0.228	0.304	0.304	83	0.564	0.444	0.506	0.423	0.423	0.564	0.564	133	0.664	0.664	0.664	0.664	0.664	0.664	0.664
34	0.610	0.593	0.610	0.663	0.632	0.712	0.632	84	0.334	0.356	0.423	0.486	0.423	0.486	0.486	134	0.664	0.664	0.664	0.664	0.664	0.664	0.664
35	0.477	0.374	0.477	0.413	0.477	0.374	0.346	85	0.451	0.546	0.487	0.451	0.546	0.451	0.451	135	0.664	0.664	0.664	0.664	0.664	0.664	0.664
36	0.593	0.502	0.536	0.593	0.477	0.477	0.502	86	0.477	0.570	0.451	0.512	0.477	0.570	0.477	136	0.664	0.664	0.664	0.664	0.664	0.664	0.664
37	0.663	0.578	0.578	0.555	0.555	0.663	0.536	87	0.641	0.740	0.663	0.624	0.641	0.663	0.663	137	0.664	0.664	0.664	0.664	0.664	0.664	0.664
38	0.700	0.632	0.649	0.670	0.748	0.649	0.632	88	0.618	0.545	0.564	0.670	0.670	0.545	0.564	138	0.664	0.664	0.664	0.664	0.664	0.664	0.664
39	0.649	0.649	0.670	0.632	0.748	0.632	0.700	89	0.712	0.697	0.732	0.712	0.760	0.732	0.712	139	0.664	0.664	0.664	0.664	0.664	0.664	0.664
40	0.578	0.601	0.632	0.684	0.632	0.578	0.560	90	0.477	0.440	0.536	0.536	0.413	0.440	0.477	140	0.664	0.664	0.664	0.664	0.664	0.664	0.664
41	0.560	0.615	0.583	0.560	0.615	0.560	0.667	91	0.434	0.396	0.496	0.496	0.346	0.396	0.496	141	0.664	0.664	0.664	0.664	0.664	0.664	0.664
42	0.658	0.695	0.695	0.658	0.695	0.658	0.770	92	0.666	0.635	0.715	0.596	0.666	0.596	0.596	142	0.664	0.664	0.664	0.664	0.664	0.664	0.664
43	0.423	0.564	0.564	0.564	0.444	0.506	0.423	93	0.444	0.444	0.444	0.284	0.284	0.444	0.378	143	0.664	0.664	0.664	0.664	0.664	0.664	0.664
44	0.521	0.521	0.521	0.396	0.423	0.461	0.374	94	0.663	0.578	0.536	0.555	0.663	0.555	0.578	144	0.664	0.664	0.664	0.664	0.664	0.664	0.664
45	0.334	0.334	0.466	0.402	0.466	0.466	0.402	95	0.527	0.615	0.502	0.502	0.560	0.615	0.502	145	0.664	0.664	0.664	0.664	0.664	0.664	0.664
46	0.512	0.451	0.477	0.477	0.477	0.570	0.570	96	0.670	0.618	0.601	0.601	0.618	0.670	0.720	146	0.664	0.664	0.664	0.664	0.664	0.664	0.664
47	0.670	0.720	0.720	0.654	0.670	0.654	0.720	97	0.496	0.521	0.555	0.610	0.610	0.477	0.521	147	0.664	0.664	0.664	0.664	0.664	0.664	0.664
48	0.536	0.536	0.477	0.502	0.502	0.593	0.536	98	0.521	0.521	0.396	0.374	0.423	0.461	0.521	148	0.664	0.664	0.664	0.664	0.664	0.664	0.664
49	0.560	0.502	0.527	0.502	0.615	0.560	0.560	99	0.583	0.560	0.560	0.560	0.615	0.615	0.667	149	0.434	0.573	0.573	0.434	0.573	0.480	0.480
50	0.545	0.632	0.521	0.632	0.502	0.521	0.578	100	0.601	0.560	0.578	0.684	0.578	0.578	0.684	150	0.545	0.486	0.545	0.486	0.402	0.486	0.423

© 2023The Authors

Table 10: Performance of the alternatives by removing each criterion (Contd..)

S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7
151	0.284	0.356	0.423	0.423	0.423	0.260	0.423	201	0.632	0.632	0.684	0.615	0.654	0.632	0.732	251	0.867	0.867	0.867	0.867	0.867	0.867	0.867
152	0.692	0.610	0.570	0.641	0.610	0.610	0.588	202	0.712	0.632	0.610	0.610	0.663	0.632	0.593	252	0.867	0.867	0.867	0.867	0.867	0.867	0.867
153	0.748	0.775	0.728	0.728	0.712	0.748	0.712	203	0.732	0.732	0.752	0.732	0.779	0.717	0.732	253	0.867	0.867	0.867	0.867	0.867	0.867	0.867
154	0.664	0.664	0.664	0.664	0.664	0.664	0.664	204	0.783	0.783	0.783	0.783	0.783	0.783	0.783	254	0.867	0.867	0.867	0.867	0.867	0.867	0.867
155	0.664	0.664	0.664	0.664	0.664	0.664	0.664	205	0.783	0.783	0.783	0.783	0.783	0.783	0.783	255	0.867	0.867	0.867	0.867	0.867	0.867	0.867
156	0.664	0.664	0.664	0.664	0.664	0.664	0.664	206	0.783	0.783	0.783	0.783	0.783	0.783	0.783	256	0.867	0.867	0.867	0.867	0.867	0.867	0.867
157	0.664	0.664	0.664	0.664	0.664	0.664	0.664	207	0.783	0.783	0.783	0.783	0.783	0.783	0.783	257	0.867	0.867	0.867	0.867	0.867	0.867	0.867
158	0.664	0.664	0.664	0.664	0.664	0.664	0.664	208	0.783	0.783	0.783	0.783	0.783	0.783	0.783	258	0.867	0.867	0.867	0.867	0.867	0.867	0.867
159	0.664	0.664	0.664	0.664	0.664	0.664	0.664	209	0.783	0.783	0.783	0.783	0.783	0.783	0.783	259	0.867	0.867	0.867	0.867	0.867	0.867	0.867
160	0.664	0.664	0.664	0.664	0.664	0.664	0.664	210	0.783	0.783	0.783	0.783	0.783	0.783	0.783	260	0.867	0.867	0.867	0.867	0.867	0.867	0.867
161	0.664	0.664	0.664	0.664	0.664	0.664	0.664	211	0.783	0.783	0.783	0.783	0.783	0.783	0.783	261	0.867	0.867	0.867	0.867	0.867	0.867	0.867
162	0.664	0.664	0.664	0.664	0.664	0.664	0.664	212	0.783	0.783	0.783	0.783	0.783	0.783	0.783	262	0.867	0.867	0.867	0.867	0.867	0.867	0.867
163	0.664	0.664	0.664	0.664	0.664	0.664	0.664	213	0.783	0.783	0.783	0.783	0.783	0.783	0.783	263	0.867	0.867	0.867	0.867	0.867	0.867	0.867
164	0.664	0.664	0.664	0.664	0.664	0.664	0.664	214	0.783	0.783	0.783	0.783	0.783	0.783	0.783	264	0.867	0.867	0.867	0.867	0.867	0.867	0.867
165	0.664	0.664	0.664	0.664	0.664	0.664	0.664	215	0.783	0.783	0.783	0.783	0.783	0.783	0.783	265	0.867	0.867	0.867	0.867	0.867	0.867	0.867
166	0.664	0.664	0.664	0.664	0.664	0.664	0.664	216	0.783	0.783	0.783	0.783	0.783	0.783	0.783	266	0.867	0.867	0.867	0.867	0.867	0.867	0.867
167	0.684	0.684	0.684	0.684	0.664	0.684	0.684	217	0.783	0.783	0.783	0.783	0.783	0.783	0.783	267	0.867	0.867	0.867	0.867	0.867	0.867	0.867
168	0.705	0.705	0.705	0.684	0.684	0.705	0.705	218	0.783	0.783	0.783	0.783	0.783	0.783	0.783	268	0.867	0.867	0.867	0.867	0.867	0.867	0.867
169	0.705	0.705	0.705	0.684	0.684	0.705	0.705	219	0.783	0.783	0.783	0.783	0.783	0.783	0.783	269	0.867	0.867	0.867	0.867	0.867	0.867	0.867
170	0.705	0.705	0.705	0.684	0.684	0.705	0.705	220	0.783	0.783	0.783	0.783	0.783	0.783	0.783	270	0.867	0.867	0.867	0.867	0.867	0.867	0.867
171	0.705	0.705	0.705	0.684	0.684	0.705	0.705	221	0.798	0.798	0.798	0.798	0.783	0.798	0.798	271	0.867	0.867	0.867	0.867	0.867	0.867	0.867
172	0.705	0.705	0.705	0.684	0.684	0.705	0.705	222	0.798	0.798	0.798	0.798	0.783	0.798	0.798	272	0.284	0.284	0.284	0.094	0.284	0.207	0.284
173	0.705	0.705	0.705	0.684	0.684	0.705	0.705	223	0.798	0.798	0.798	0.798	0.783	0.798	0.798	273	0.578	0.560	0.632	0.632	0.632	0.601	0.632
174	0.705	0.705	0.705	0.684	0.684	0.705	0.705	224	0.812	0.812	0.812	0.798	0.798	0.812	0.812	274	0.770	0.804	0.804	0.770	0.770	0.770	0.804
175	0.705	0.705	0.705	0.684	0.684	0.705	0.705	225	0.812	0.812	0.812	0.798	0.798	0.812	0.812	275	0.646	0.593	0.615	0.615	0.697	0.593	0.593
176	0.745	0.725	0.745	0.725	0.725	0.725	0.745	226	0.812	0.812	0.812	0.798	0.798	0.812	0.812	276	0.304	0.304	0.304	0.181	0.146	0.304	0.304
177	0.745	0.725	0.745	0.725	0.725	0.725	0.745	227	0.826	0.812	0.826	0.812	0.812	0.826	0.826	277	0.477	0.502	0.536	0.477	0.593	0.593	0.502
178	0.745	0.745	0.764	0.745	0.745	0.745	0.764	228	0.826	0.812	0.826	0.812	0.812	0.826	0.826	278	0.715	0.735	0.808	0.700	0.715	0.700	0.700
179	0.745	0.745	0.764	0.745	0.745	0.745	0.764	229	0.826	0.812	0.826	0.812	0.812	0.826	0.826	279	0.601	0.545	0.654	0.545	0.545	0.654	0.527
180	0.745	0.745	0.764	0.745	0.745	0.745	0.764	230	0.826	0.812	0.826	0.812	0.812	0.826	0.826	280	0.632	0.684	0.632	0.560	0.601	0.578	0.578
181	0.745	0.745	0.764	0.745	0.745	0.745	0.764	231	0.840	0.826	0.840	0.826	0.826	0.826	0.840	281	0.444	0.540	0.396	0.396	0.540	0.540	0.480
182	0.764	0.764	0.783	0.764	0.764	0.764	0.764	232	0.840	0.826	0.840	0.826	0.826	0.826	0.840	282	0.260	0.334	0.260	0.402	0.402	0.402	0.402
183	0.764	0.764	0.783	0.764	0.764	0.764	0.764	233	0.840	0.826	0.840	0.826	0.826	0.826	0.840	283	0.578	0.440	0.521	0.578	0.486	0.521	0.461
184	0.783	0.783	0.783	0.783	0.783	0.783	0.783	234	0.853	0.840	0.853	0.840	0.840	0.840	0.840	284	0.486	0.564	0.564	0.618	0.618	0.486	0.506
185	0.783	0.783	0.783	0.783	0.783	0.783	0.783	235	0.853	0.853	0.867	0.853	0.853	0.853	0.853	285	0.521	0.486	0.578	0.440	0.521	0.521	0.521
186	0.783	0.783	0.783	0.783	0.783	0.783	0.783	236	0.853	0.853	0.867	0.853	0.853	0.853	0.853	286	0.560	0.466	0.440	0.440	0.440	0.560	0.560
187	0.783	0.783	0.783	0.783	0.783	0.783	0.783	237	0.867	0.867	0.867	0.867	0.867	0.867	0.867	287	0.531	0.386	0.434	0.531	0.434	0.531	0.434
188	0.783	0.783	0.783	0.783	0.783	0.783	0.783	238	0.867	0.867	0.867	0.867	0.867	0.867	0.867	288	0.822	0.715	0.715	0.715	0.731	0.715	0.750
189	0.783	0.783	0.783	0.783	0.783	0.783	0.783	239	0.867	0.867	0.867	0.867	0.867	0.867	0.867	289	0.555	0.461	0.496	0.461	0.413	0.555	0.496
190	0.783	0.783	0.783	0.783	0.783	0.783	0.783	240	0.867	0.867	0.867	0.867	0.867	0.867	0.867	290	0.531	0.619	0.531	0.531	0.531	0.487	0.619
191	0.783	0.783	0.783	0.783	0.783	0.783	0.783	241	0.867	0.867	0.867	0.867	0.867	0.867	0.867	291	0.527	0.527	0.466	0.402	0.402	0.466	0.466
192	0.783	0.783	0.783	0.783	0.783	0.783	0.783	242	0.867	0.867	0.867	0.867	0.867	0.867	0.867	292	0.536	0.570	0.536	0.624	0.536	0.570	0.512
193	0.783	0.783	0.783	0.783	0.783	0.783	0.783	243	0.867	0.867	0.867	0.867	0.867	0.867	0.867	293	0.679	0.663	0.679	0.663	0.775	0.700	0.700
194	0.783	0.783	0.783	0.783	0.783	0.783	0.783	244	0.867	0.867	0.867	0.867	0.867	0.867	0.867	294	0.666	0.715	0.635	0.596	0.666	0.596	0.596
195	0.783	0.783	0.783	0.783	0.783	0.783	0.783	245	0.867	0.867	0.867	0.867	0.867	0.867	0.867								
196	0.783	0.783	0.783	0.783	0.783	0.783	0.783	246	0.867	0.867	0.867	0.867	0.867	0.867	0.867								
197	0.783	0.783	0.783	0.783	0.783	0.783	0.783	247	0.867	0.867	0.867	0.867	0.867	0.867	0.867								
198	0.783	0.783	0.783	0.783	0.783	0.783	0.783	248	0.867	0.867	0.867	0.867	0.867	0.867	0.867								
199	0.540	0.480	0.396	0.396	0.444	0.540	0.540	249	0.867	0.867	0.867	0.867	0.867	0.867	0.867								
200	0.402	0.423	0.545	0.486	0.545	0.423	0.545	250	0.867	0.867	0.867	0.867	0.867	0.867	0.867								

© 2023The Authors

4.2.5 Absolute deviations: Summations of absolute dedviations are determined as discussed in section 2.2 and the vaues are presented in the following table

Table 11: Absolute deviations

S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7
1	0.110	0.074	0.094	0.000	0.074	0.110	0.110	51	0.110	0.094	0.110	0.110	0.000	0.046	0.110	101	0.119	0.000	0.049	0.119	0.101	0.049	0.101
2	0.000	0.130	0.000	0.130	0.000	0.111	0.130	52	0.081	0.121	0.050	0.000	0.104	0.050	0.121	102	0.000	0.137	0.091	0.091	0.057	0.000	0.091
3	0.000	0.000	0.084	0.084	0.126	0.108	0.108	53	0.125	0.052	0.000	0.125	0.052	0.107	0.052	103	0.098	0.000	0.000	0.147	0.000	0.125	0.061
4	0.098	0.115	0.000	0.115	0.000	0.115	0.115	54	0.000	0.104	0.081	0.104	0.051	0.081	0.104	104	0.052	0.084	0.126	0.052	0.084	0.000	0.108
5	0.000	0.091	0.091	0.116	0.056	0.056	0.056	55	0.093	0.073	0.093	0.045	0.093	0.073	0.108	105	0.000	0.127	0.053	0.053	0.053	0.109	0.109
6	0.074	0.094	0.110	0.000	0.094	0.094	0.110	56	0.048	0.098	0.098	0.115	0.000	0.098	0.098	106	0.114	0.000	0.000	0.055	0.089	0.089	0.133
7	0.080	0.080	0.120	0.080	0.120	0.000	0.050	57	0.000	0.149	0.000	0.062	0.149	0.062	0.000	107	0.062	0.062	0.000	0.128	0.062	0.000	0.100
8	0.109	0.053	0.109	0.000	0.127	0.000	0.109	58	0.074	0.110	0.000	0.110	0.110	0.074	0.094	108	0.151	0.000	0.100	0.062	0.000	0.100	0.000
9	0.074	0.094	0.094	0.094	0.046	0.094	0.074	59	0.089	0.133	0.114	0.000	0.000	0.055	0.089	109	0.081	0.103	0.050	0.081	0.081	0.050	0.081
10	0.101	0.086	0.068	0.101	0.101	0.068	0.086	60	0.071	0.114	0.000	0.071	0.000	0.000	0.071	110	0.048	0.078	0.048	0.078	0.099	0.078	0.116
11	0.103	0.103	0.000	0.000	0.103	0.103	0.121	61	0.115	0.115	0.000	0.048	0.098	0.077	0.098	111	0.118	0.118	0.138	0.092	0.000	0.000	0.000
12	0.122	0.082	0.082	0.122	0.122	0.000	0.000	62	0.121	0.121	0.081	0.000	0.050	0.050	0.104	112	0.000	0.096	0.096	0.060	0.123	0.000	0.060
13	0.000	0.068	0.068	0.110	0.000	0.000	0.110	63	0.000	0.125	0.000	0.052	0.125	0.107	0.107	113	0.056	0.000	0.135	0.000	0.135	0.056	0.090
14	0.123	0.123	0.105	0.000	0.051	0.123	0.000	64	0.047	0.113	0.096	0.096	0.113	0.000	0.096	114	0.053	0.109	0.000	0.109	0.000	0.127	0.109
15	0.086	0.054	0.086	0.086	0.054	0.000	0.129	65	0.113	0.000	0.113	0.096	0.096	0.047	0.096	115	0.104	0.000	0.000	0.104	0.081	0.121	0.121
16	0.098	0.077	0.077	0.077	0.000	0.114	0.114	66	0.060	0.123	0.096	0.000	0.096	0.060	0.000	116	0.092	0.057	0.057	0.000	0.000	0.118	0.138
17	0.122	0.082	0.000	0.082	0.122	0.122	0.000	67	0.069	0.000	0.000	0.069	0.000	0.069	0.142	117	0.054	0.088	0.054	0.088	0.088	0.054	0.054
18	0.107	0.072	0.045	0.072	0.107	0.107	0.072	68	0.124	0.083	0.106	0.000	0.083	0.000	0.124	118	0.085	0.085	0.053	0.085	0.085	0.053	0.053
19	0.045	0.092	0.108	0.092	0.092	0.108	0.045	69	0.119	0.050	0.080	0.000	0.119	0.050	0.119	119	0.085	0.085	0.053	0.085	0.085	0.053	0.053
20	0.130	0.054	0.111	0.087	0.000	0.054	0.054	70	0.104	0.050	0.121	0.000	0.121	0.050	0.081	120	0.085	0.085	0.053	0.085	0.085	0.053	0.053
21	0.083	0.000	0.000	0.124	0.083	0.106	0.124	71	0.000	0.000	0.097	0.097	0.000	0.145	0.097	121	0.085	0.085	0.053	0.085	0.085	0.053	0.053
22	0.059	0.142	0.000	0.094	0.000	0.059	0.094	72	0.115	0.098	0.000	0.115	0.048	0.077	0.098	122	0.085	0.085	0.053	0.085	0.085	0.053	0.053
23	0.115	0.115	0.115	0.115	0.000	0.098	0.000	73	0.050	0.119	0.119	0.080	0.000	0.050	0.119	123	0.082	0.082	0.082	0.082	0.082	0.051	0.051
24	0.103	0.103	0.000	0.050	0.050	0.103	0.121	74	0.000	0.055	0.133	0.000	0.089	0.114	0.089	124	0.082	0.082	0.082	0.082	0.082	0.051	0.051
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	0.087	0.111	0.000	0.111	0.130	0.054	0.000	125	0.078	0.078	0.078	0.078	0.078	0.078	0.078
26	0.096	0.000	0.096	0.123	0.000	0.060	0.060	76	0.060	0.060	0.060	0.060	0.060	0.060	0.060	126	0.078	0.078	0.078	0.078	0.078	0.078	0.078
27	0.114	0.000	0.077	0.077	0.077	0.114	0.098	77	0.060	0.060	0.060	0.060	0.060	0.060	0.060	127	0.078	0.078	0.078	0.078	0.078	0.078	0.078
28	0.103	0.103	0.050	0.050	0.050	0.121	0.050	78	0.060	0.060	0.060	0.060	0.060	0.060	0.060	128	0.078	0.078	0.078	0.078	0.078	0.078	0.078
29	0.059	0.094	0.059	0.000	0.142	0.094	0.000	79	0.060	0.060	0.060	0.060	0.060	0.060	0.060	129	0.078	0.078	0.078	0.078	0.078	0.078	0.078
30	0.163	0.067	0.000	0.067	0.067	0.000	0.000	80	0.060	0.060	0.060	0.060	0.060	0.060	0.060	130	0.078	0.078	0.078	0.078	0.078	0.078	0.078
31	0.089	0.105	0.089	0.105	0.000	0.105	0.105	81	0.060	0.060	0.060	0.060	0.060	0.060	0.060	131	0.078	0.078	0.078	0.078	0.078	0.078	0.078
32	0.047	0.075	0.095	0.095	0.047	0.112	0.095	82	0.000	0.097	0.097	0.145	0.000	0.000	0.097	132	0.078	0.078	0.078	0.078	0.078	0.078	0.078
33	0.123	0.000	0.076	0.000	0.076	0.000	0.000	83	0.000	0.120	0.058	0.140	0.140	0.000	0.000	133	0.078	0.078	0.078	0.078	0.078	0.078	0.078
34	0.102	0.120	0.102	0.050	0.080	0.000	0.080	84	0.152	0.130	0.063	0.000	0.063	0.000	0.000	134	0.078	0.078	0.078	0.078	0.078	0.078	0.078
35	0.000	0.103	0.000	0.063	0.000	0.103	0.131	85	0.095	0.000	0.059	0.095	0.000	0.095	0.095	135	0.078	0.078	0.078	0.078	0.078	0.078	0.078
36	0.000	0.091	0.056	0.000	0.116	0.116	0.091	86	0.093	0.000	0.119	0.058	0.093	0.000	0.093	136	0.078	0.078	0.078	0.078	0.078	0.078	0.078
37	0.000	0.084	0.084	0.108	0.108	0.000	0.126	87	0.099	0.000	0.078	0.116	0.099	0.078	0.078	137	0.078	0.078	0.078	0.078	0.078	0.078	0.078
38	0.048	0.115	0.098	0.077	0.000	0.098	0.115	88	0.052	0.125	0.107	0.000	0.000	0.125	0.107	138	0.078	0.078	0.078	0.078	0.078	0.078	0.078
39	0.098	0.098	0.077	0.115	0.000	0.115	0.048	89	0.093	0.108	0.073	0.093	0.045	0.073	0.093	139	0.078	0.078	0.078	0.078	0.078	0.078	0.078
40	0.105	0.083	0.051	0.000	0.051	0.105	0.123	90	0.060	0.096	0.000	0.000	0.123	0.096	0.060	140	0.078	0.078	0.078	0.078	0.078	0.078	0.078
41	0.107	0.052	0.084	0.107	0.052	0.107	0.000	91	0.062	0.100	0.000	0.000	0.151	0.100	0.000	141	0.078	0.078	0.078	0.078	0.078	0.078	0.078
42	0.113	0.075	0.075	0.113	0.075	0.113	0.000	92	0.050	0.080	0.000	0.119	0.050	0.119	0.119	142	0.078	0.078	0.078	0.078	0.078	0.078	0.078
43	0.140	0.000	0.000	0.000	0.120	0.058	0.140	93	0.000	0.000	0.000	0.160	0.160	0.000	0.066	143	0.078	0.078	0.078	0.078	0.078	0.078	0.078
44	0.000	0.000	0.000	0.125	0.098	0.061	0.147	94	0.000	0.084	0.126	0.108	0.000	0.108	0.084	144	0.078	0.078	0.078	0.078	0.078	0.078	0.078
45	0.133	0.133	0.000	0.064	0.000	0.000	0.064	95	0.089	0.000	0.113	0.113	0.055	0.000	0.113	145	0.078	0.078	0.078	0.078	0.078	0.078	0.078
46	0.058	0.119	0.093	0.093	0.093	0.000	0.000	96	0.049	0.101	0.119	0.119	0.101	0.049	0.000	146	0.078	0.078	0.078	0.078	0.078	0.078	0.078
47	0.096	0.047	0.047	0.113	0.096	0.113	0.047	97	0.114	0.089	0.055	0.000	0.000	0.133	0.089	147	0.078	0.078	0.078	0.078	0.078	0.078	0.078
48	0.056	0.056	0.116	0.091	0.091	0.000	0.056	98	0.000	0.000	0.125	0.147	0.098	0.061	0.000	148	0.078	0.078	0.078	0.078	0.078	0.078	0.078
49	0.055	0.113	0.089	0.113	0.000	0.055	0.055	99	0.084	0.107	0.107	0.107	0.052	0.052	0.000	149	0.139	0.000	0.000	0.139	0.000	0.093	0.093
50	0.087	0.000	0.111	0.000	0.130	0.111	0.054	100	0.083	0.123	0.105	0.000	0.105	0.105	0.000	150	0.000	0.059	0.000	0.059	0.143	0.059	0.122

© 2023The Authors

Table 11: Summation of absolute deviations (Contd..)

S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7
151	0.139	0.067	0.000	0.000	0.000	0.163	0.000	201	0.100	0.100	0.049	0.117	0.078	0.100	0.000	251	0.092	0.092	0.092	0.092	0.092	0.092	0.092
152	0.000	0.082	0.122	0.051	0.082	0.082	0.104	202	0.000	0.080	0.102	0.102	0.050	0.080	0.120	252	0.092	0.092	0.092	0.092	0.092	0.092	0.092
153	0.072	0.045	0.091	0.091	0.107	0.072	0.107	203	0.091	0.091	0.071	0.091	0.044	0.106	0.091	253	0.092	0.092	0.092	0.092	0.092	0.092	0.092
154	0.078	0.078	0.078	0.078	0.078	0.078	0.078	204	0.087	0.087	0.087	0.087	0.087	0.087	0.087	254	0.092	0.092	0.092	0.092	0.092	0.092	0.092
155	0.078	0.078	0.078	0.078	0.078	0.078	0.078	205	0.087	0.087	0.087	0.087	0.087	0.087	0.087	255	0.092	0.092	0.092	0.092	0.092	0.092	0.092
156	0.078	0.078	0.078	0.078	0.078	0.078	0.078	206	0.087	0.087	0.087	0.087	0.087	0.087	0.087	256	0.092	0.092	0.092	0.092	0.092	0.092	0.092
157	0.078	0.078	0.078	0.078	0.078	0.078	0.078	207	0.087	0.087	0.087	0.087	0.087	0.087	0.087	257	0.092	0.092	0.092	0.092	0.092	0.092	0.092
158	0.078	0.078	0.078	0.078	0.078	0.078	0.078	208	0.087	0.087	0.087	0.087	0.087	0.087	0.087	258	0.092	0.092	0.092	0.092	0.092	0.092	0.092
159	0.078	0.078	0.078	0.078	0.078	0.078	0.078	209	0.087	0.087	0.087	0.087	0.087	0.087	0.087	259	0.092	0.092	0.092	0.092	0.092	0.092	0.092
160	0.078	0.078	0.078	0.078	0.078	0.078	0.078	210	0.087	0.087	0.087	0.087	0.087	0.087	0.087	260	0.092	0.092	0.092	0.092	0.092	0.092	0.092
161	0.078	0.078	0.078	0.078	0.078	0.078	0.078	211	0.087	0.087	0.087	0.087	0.087	0.087	0.087	261	0.092	0.092	0.092	0.092	0.092	0.092	0.092
162	0.078	0.078	0.078	0.078	0.078	0.078	0.078	212	0.087	0.087	0.087	0.087	0.087	0.087	0.087	262	0.092	0.092	0.092	0.092	0.092	0.092	0.092
163	0.078	0.078	0.078	0.078	0.078	0.078	0.078	213	0.087	0.087	0.087	0.087	0.087	0.087	0.087	263	0.092	0.092	0.092	0.092	0.092	0.092	0.092
164	0.078	0.078	0.078	0.078	0.078	0.078	0.078	214	0.087	0.087	0.087	0.087	0.087	0.087	0.087	264	0.092	0.092	0.092	0.092	0.092	0.092	0.092
165	0.078	0.078	0.078	0.078	0.078	0.078	0.078	215	0.087	0.087	0.087	0.087	0.087	0.087	0.087	265	0.092	0.092	0.092	0.092	0.092	0.092	0.092
166	0.078	0.078	0.078	0.078	0.078	0.078	0.078	216	0.087	0.087	0.087	0.087	0.087	0.087	0.087	266	0.092	0.092	0.092	0.092	0.092	0.092	0.092
167	0.076	0.076	0.076	0.076	0.097	0.076	0.076	217	0.087	0.087	0.087	0.087	0.087	0.087	0.087	267	0.092	0.092	0.092	0.092	0.092	0.092	0.092
168	0.075	0.075	0.075	0.095	0.095	0.075	0.075	218	0.087	0.087	0.087	0.087	0.087	0.087	0.087	268	0.092	0.092	0.092	0.092	0.092	0.092	0.092
169	0.075	0.075	0.075	0.095	0.095	0.075	0.075	219	0.087	0.087	0.087	0.087	0.087	0.087	0.087	269	0.092	0.092	0.092	0.092	0.092	0.092	0.092
170	0.075	0.075	0.075	0.095	0.095	0.075	0.075	220	0.087	0.087	0.087	0.087	0.087	0.087	0.087	270	0.092	0.092	0.092	0.092	0.092	0.092	0.092
171	0.075	0.075	0.075	0.095	0.095	0.075	0.075	221	0.085	0.085	0.085	0.085	0.100	0.085	0.085	271	0.092	0.092	0.092	0.092	0.092	0.092	0.092
172	0.075	0.075	0.075	0.095	0.095	0.075	0.075	222	0.085	0.085	0.085	0.085	0.100	0.085	0.085	272	0.000	0.000	0.000	0.190	0.000	0.077	0.000
173	0.075	0.075	0.075	0.095	0.095	0.075	0.075	223	0.085	0.085	0.085	0.085	0.100	0.085	0.085	273	0.105	0.123	0.051	0.051	0.051	0.083	0.051
174	0.075	0.075	0.075	0.095	0.095	0.075	0.075	224	0.084	0.084	0.084	0.099	0.099	0.084	0.084	274	0.101	0.068	0.068	0.101	0.101	0.101	0.068
175	0.075	0.075	0.075	0.095	0.095	0.075	0.075	225	0.084	0.084	0.084	0.099	0.099	0.084	0.084	275	0.051	0.104	0.081	0.081	0.000	0.104	0.104
176	0.072	0.092	0.072	0.092	0.092	0.092	0.072	226	0.084	0.084	0.084	0.099	0.099	0.084	0.084	276	0.000	0.000	0.000	0.123	0.158	0.000	0.000
177	0.072	0.092	0.072	0.092	0.092	0.092	0.072	227	0.083	0.097	0.083	0.097	0.097	0.083	0.083	277	0.116	0.091	0.056	0.116	0.000	0.000	0.091
178	0.090	0.090	0.071	0.090	0.090	0.090	0.071	228	0.083	0.097	0.083	0.097	0.097	0.083	0.083	278	0.092	0.073	0.000	0.108	0.092	0.108	0.108
179	0.090	0.090	0.071	0.090	0.090	0.090	0.071	229	0.083	0.097	0.083	0.097	0.097	0.083	0.083	279	0.053	0.109	0.000	0.109	0.109	0.000	0.127
180	0.090	0.090	0.071	0.090	0.090	0.090	0.071	230	0.083	0.097	0.083	0.097	0.097	0.083	0.083	280	0.051	0.000	0.051	0.123	0.083	0.105	0.105
181	0.090	0.090	0.071	0.090	0.090	0.090	0.071	231	0.082	0.096	0.082	0.096	0.096	0.096	0.082	281	0.096	0.000	0.144	0.144	0.000	0.000	0.059
182	0.088	0.088	0.069	0.088	0.088	0.088	0.088	232	0.082	0.096	0.082	0.096	0.096	0.096	0.082	282	0.142	0.069	0.142	0.000	0.000	0.000	0.000
183	0.088	0.088	0.069	0.088	0.088	0.088	0.088	233	0.082	0.096	0.082	0.096	0.096	0.096	0.082	283	0.000	0.138	0.057	0.000	0.092	0.057	0.118
184	0.087	0.087	0.087	0.087	0.087	0.087	0.087	234	0.081	0.095	0.081	0.095	0.095	0.095	0.095	284	0.132	0.055	0.055	0.000	0.000	0.132	0.113
185	0.087	0.087	0.087	0.087	0.087	0.087	0.087	235	0.093	0.093	0.080	0.093	0.093	0.093	0.093	285	0.057	0.092	0.000	0.138	0.057	0.057	0.057
186	0.087	0.087	0.087	0.087	0.087	0.087	0.087	236	0.093	0.093	0.080	0.093	0.093	0.093	0.093	286	0.000	0.094	0.120	0.120	0.120	0.000	0.000
187	0.087	0.087	0.087	0.087	0.087	0.087	0.087	237	0.092	0.092	0.092	0.092	0.092	0.092	0.092	287	0.000	0.145	0.097	0.000	0.097	0.000	0.097
188	0.087	0.087	0.087	0.087	0.087	0.087	0.087	238	0.092	0.092	0.092	0.092	0.092	0.092	0.092	288	0.000	0.107	0.107	0.107	0.091	0.107	0.071
189	0.087	0.087	0.087	0.087	0.087	0.087	0.087	239	0.092	0.092	0.092	0.092	0.092	0.092	0.092	289	0.000	0.094	0.059	0.094	0.142	0.000	0.059
190	0.087	0.087	0.087	0.087	0.087	0.087	0.087	240	0.092	0.092	0.092	0.092	0.092	0.092	0.092	290	0.088	0.000	0.088	0.088	0.088	0.132	0.000
191	0.087	0.087	0.087	0.087	0.087	0.087	0.087	241	0.092	0.092	0.092	0.092	0.092	0.092	0.092	291	0.000	0.000	0.060	0.124	0.124	0.060	0.060
192	0.087	0.087	0.087	0.087	0.087	0.087	0.087	242	0.092	0.092	0.092	0.092	0.092	0.092	0.092	292	0.088	0.054	0.088	0.000	0.088	0.054	0.112
193	0.087	0.087	0.087	0.087	0.087	0.087	0.087	243	0.092	0.092	0.092	0.092	0.092	0.092	0.092	293	0.096	0.112	0.096	0.112	0.000	0.075	0.075
194	0.087	0.087	0.087	0.087	0.087	0.087	0.087	244	0.092	0.092	0.092	0.092	0.092	0.092	0.092	294	0.050	0.000	0.080	0.119	0.050	0.119	0.119
195	0.087	0.087	0.087	0.087	0.087	0.087	0.087	245	0.092	0.092	0.092	0.092	0.092	0.092	0.092								
196	0.087	0.087	0.087	0.087	0.087	0.087	0.087	246	0.092	0.092	0.092	0.092	0.092	0.092	0.092								
197	0.087	0.087	0.087	0.087	0.087	0.087	0.087	247	0.092	0.092	0.092	0.092	0.092	0.092	0.092								
198	0.087	0.087	0.087	0.087	0.087	0.087	0.087	248	0.092	0.092	0.092	0.092	0.092	0.092	0.092								
199	0.000	0.059	0.144	0.144	0.096	0.000	0.000	249	0.092	0.092	0.092	0.092	0.092	0.092	0.092								
200	0.143	0.122	0.000	0.059	0.000	0.122	0.000	250	0.092	0.092	0.092	0.092	0.092	0.092	0.092								

© 2023The Authors

Table 12: Weights of the criteria. Weights of the criteria are determined as discussed in section 2.2 and the values are presented in the following table

Relative weights of Empathy Criteria (MEREC)

Criteria	EM1	EM2	EM3	EM4	EM5	EM6	EM7
Summation of Deviations	22.664	23.27	21.5	23.722	22.318	22.14	22.884
Relative weights	0.143	0.1468	0.1356	0.1497	0.1408	0.1397	0.1444

Similarly, the relative weights of the criteria of tangibles (TA), Safety (SA), Efficiency (EF), Degree of improvement (DI) and Operational Performance (OP) are determined and presented in the following table.

Table 13: Relative weights of the criteria (MEREC Method)

Criteria	Rel.Wt	Criteria	Rel.Wt
EM1	0.1430	EF1	0.1618
EM2	0.1468	EF2	0.1717
EM3	0.1356	EF3	0.1656
EM4	0.1497	EF4	0.1730
EM5	0.1408	EF5	0.1677
EM6	0.1397	EF6	0.1601
EM7	0.1444	DI1	0.1217
TA1	0.1870	DI2	0.1240
TA2	0.2066	DI3	0.1289
TA3	0.2046	DI4	0.1253
TA4	0.2096	DI5	0.1233
TA5	0.1922	DI6	0.1254
SA1	0.1668	DI7	0.1296
SA2	0.1627	DI8	0.1217
SA3	0.1697	OP1	0.1883
SA4	0.1634	OP2	0.2107
SA5	0.1670	OP3	0.2055
SA6	0.1705	OP4	0.1982
		OP5	0.1973

© 2023The Authors

4.3 ENTROPY METHOD

4.3.1 Decision matrix: Decision matrix is formulated and is presented in appendix (Table A.1)

4.3.2 Proportion of the sample: Proportion of the each sample is determined as discussed in section 2.3 and the values are presented in the following table

Table: 14: Proportion of the sample

S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7
1	0.005	0.003	0.004	0.001	0.003	0.005	0.005	51	0.005	0.004	0.005	0.005	0.001	0.002	0.005	101	0.005	0.001	0.002	0.005	0.004	0.002	0.004
2	0.001	0.005	0.001	0.005	0.001	0.004	0.005	52	0.003	0.005	0.002	0.001	0.004	0.002	0.005	102	0.001	0.005	0.003	0.003	0.002	0.001	0.003
3	0.001	0.001	0.003	0.003	0.005	0.004	0.004	53	0.005	0.002	0.001	0.005	0.002	0.004	0.002	103	0.003	0.001	0.001	0.005	0.001	0.004	0.002
4	0.004	0.005	0.001	0.005	0.001	0.005	0.005	54	0.001	0.004	0.003	0.004	0.002	0.003	0.004	104	0.002	0.003	0.005	0.002	0.003	0.001	0.004
5	0.001	0.003	0.003	0.004	0.002	0.002	0.002	55	0.004	0.003	0.004	0.002	0.004	0.003	0.005	105	0.001	0.005	0.002	0.002	0.002	0.004	0.004
6	0.003	0.004	0.005	0.001	0.004	0.004	0.005	56	0.002	0.004	0.004	0.005	0.001	0.004	0.004	106	0.004	0.001	0.001	0.002	0.003	0.003	0.005
7	0.003	0.003	0.005	0.003	0.005	0.001	0.002	57	0.001	0.005	0.001	0.002	0.005	0.002	0.001	107	0.002	0.002	0.001	0.004	0.002	0.001	0.003
8	0.004	0.002	0.004	0.001	0.005	0.001	0.004	58	0.003	0.005	0.001	0.005	0.005	0.003	0.004	108	0.005	0.001	0.003	0.002	0.001	0.003	0.001
9	0.003	0.004	0.004	0.004	0.002	0.004	0.003	59	0.003	0.005	0.004	0.001	0.001	0.002	0.003	109	0.003	0.004	0.002	0.003	0.003	0.002	0.003
10	0.005	0.004	0.003	0.005	0.005	0.003	0.004	60	0.002	0.003	0.001	0.002	0.001	0.001	0.002	110	0.002	0.003	0.002	0.003	0.004	0.003	0.005
11	0.004	0.004	0.001	0.001	0.004	0.004	0.005	61	0.005	0.005	0.001	0.002	0.004	0.003	0.004	111	0.004	0.004	0.005	0.003	0.001	0.001	0.001
12	0.005	0.003	0.003	0.005	0.005	0.001	0.001	62	0.005	0.005	0.003	0.001	0.002	0.002	0.004	112	0.001	0.003	0.003	0.002	0.004	0.001	0.002
13	0.001	0.002	0.002	0.003	0.001	0.001	0.003	63	0.001	0.005	0.001	0.002	0.005	0.004	0.004	113	0.002	0.001	0.005	0.001	0.005	0.002	0.003
14	0.005	0.005	0.004	0.001	0.002	0.005	0.001	64	0.002	0.005	0.004	0.004	0.005	0.001	0.004	114	0.002	0.004	0.001	0.004	0.001	0.005	0.004
15	0.003	0.002	0.003	0.003	0.002	0.001	0.005	65	0.005	0.001	0.005	0.004	0.004	0.002	0.004	115	0.004	0.001	0.001	0.004	0.003	0.005	0.005
16	0.004	0.003	0.003	0.003	0.001	0.005	0.005	66	0.002	0.004	0.003	0.001	0.003	0.002	0.001	116	0.003	0.002	0.002	0.001	0.001	0.004	0.005
17	0.005	0.003	0.001	0.003	0.005	0.005	0.001	67	0.002	0.001	0.001	0.002	0.001	0.002	0.004	117	0.002	0.003	0.002	0.003	0.003	0.002	0.002
18	0.005	0.003	0.002	0.003	0.005	0.005	0.003	68	0.005	0.003	0.004	0.001	0.003	0.001	0.005	118	0.003	0.003	0.002	0.003	0.003	0.002	0.002
19	0.002	0.004	0.005	0.004	0.004	0.005	0.002	69	0.005	0.002	0.003	0.001	0.005	0.002	0.005	119	0.003	0.003	0.002	0.003	0.003	0.002	0.002
20	0.005	0.002	0.004	0.003	0.001	0.002	0.002	70	0.004	0.002	0.005	0.001	0.005	0.002	0.003	120	0.003	0.003	0.002	0.003	0.003	0.002	0.002
21	0.003	0.001	0.001	0.005	0.003	0.004	0.005	71	0.001	0.001	0.003	0.003	0.001	0.005	0.003	121	0.003	0.003	0.002	0.003	0.003	0.002	0.002
22	0.002	0.005	0.001	0.003	0.001	0.002	0.003	72	0.005	0.004	0.001	0.005	0.002	0.003	0.004	122	0.003	0.003	0.002	0.003	0.003	0.002	0.002
23	0.005	0.005	0.005	0.005	0.001	0.004	0.001	73	0.002	0.005	0.005	0.003	0.001	0.002	0.005	123	0.003	0.003	0.003	0.003	0.003	0.002	0.002
24	0.004	0.004	0.001	0.002	0.002	0.004	0.005	74	0.001	0.002	0.005	0.001	0.003	0.004	0.003	124	0.003	0.003	0.003	0.003	0.003	0.002	0.002
25	0.001	0.001	0.001	0.001	0.001	0.001	0.001	75	0.003	0.004	0.001	0.004	0.005	0.002	0.001	125	0.003	0.003	0.003	0.003	0.003	0.003	0.003
26	0.003	0.001	0.003	0.004	0.001	0.002	0.002	76	0.002	0.002	0.002	0.002	0.002	0.002	0.002	126	0.003	0.003	0.003	0.003	0.003	0.003	0.003
27	0.005	0.001	0.003	0.003	0.003	0.005	0.004	77	0.002	0.002	0.002	0.002	0.002	0.002	0.002	127	0.003	0.003	0.003	0.003	0.003	0.003	0.003
28	0.004	0.004	0.002	0.002	0.002	0.005	0.002	78	0.002	0.002	0.002	0.002	0.002	0.002	0.002	128	0.003	0.003	0.003	0.003	0.003	0.003	0.003
29	0.002	0.003	0.002	0.001	0.005	0.003	0.001	79	0.002	0.002	0.002	0.002	0.002	0.002	0.002	129	0.003	0.003	0.003	0.003	0.003	0.003	0.003
30	0.005	0.002	0.001	0.002	0.002	0.001	0.001	80	0.002	0.002	0.002	0.002	0.002	0.002	0.002	130	0.003	0.003	0.003	0.003	0.003	0.003	0.003
31	0.004	0.005	0.004	0.005	0.001	0.005	0.005	81	0.002	0.002	0.002	0.002	0.002	0.002	0.002	131	0.003	0.003	0.003	0.003	0.003	0.003	0.003
32	0.002	0.003	0.004	0.004	0.002	0.005	0.004	82	0.001	0.003	0.003	0.005	0.001	0.001	0.003	132	0.003	0.003	0.003	0.003	0.003	0.003	0.003
33	0.003	0.001	0.002	0.001	0.002	0.001	0.001	83	0.001	0.004	0.002	0.005	0.005	0.001	0.001	133	0.003	0.003	0.003	0.003	0.003	0.003	0.003
34	0.004	0.005	0.004	0.002	0.003	0.001	0.003	84	0.005	0.004	0.002	0.001	0.002	0.001	0.001	134	0.003	0.003	0.003	0.003	0.003	0.003	0.003
35	0.001	0.003	0.001	0.002	0.001	0.003	0.004	85	0.003	0.001	0.002	0.003	0.001	0.003	0.003	135	0.003	0.003	0.003	0.003	0.003	0.003	0.003
36	0.001	0.003	0.002	0.001	0.004	0.004	0.003	86	0.003	0.001	0.004	0.002	0.003	0.001	0.003	136	0.003	0.003	0.003	0.003	0.003	0.003	0.003
37	0.001	0.003	0.003	0.004	0.004	0.001	0.005	87	0.004	0.001	0.003	0.005	0.004	0.003	0.003	137	0.003	0.003	0.003	0.003	0.003	0.003	0.003
38	0.002	0.005	0.004	0.003	0.001	0.004	0.005	88	0.002	0.005	0.004	0.001	0.001	0.005	0.004	138	0.003	0.003	0.003	0.003	0.003	0.003	0.003
39	0.004	0.004	0.003	0.005	0.001	0.005	0.002	89	0.004	0.005	0.003	0.004	0.002	0.003	0.004	139	0.003	0.003	0.003	0.003	0.003	0.003	0.003
40	0.004	0.003	0.002	0.001	0.002	0.004	0.005	90	0.002	0.003	0.001	0.001	0.004	0.003	0.002	140	0.003	0.003	0.003	0.003	0.003	0.003	0.003
41	0.004	0.002	0.003	0.004	0.002	0.004	0.001	91	0.002	0.003	0.001	0.001	0.005	0.003	0.001	141	0.003	0.003	0.003	0.003	0.003	0.003	0.003
42	0.005	0.003	0.003	0.005	0.003	0.005	0.001	92	0.002	0.003	0.001	0.005	0.002	0.005	0.005	142	0.003	0.003	0.003	0.003	0.003	0.003	0.003
43	0.005	0.001	0.001	0.001	0.004	0.002	0.005	93	0.001	0.001	0.001	0.005	0.005	0.001	0.002	143	0.003	0.003	0.003	0.003	0.003	0.003	0.003
44	0.001	0.001	0.001	0.004	0.003	0.002	0.005	94	0.001	0.003	0.005	0.004	0.001	0.004	0.003	144	0.003	0.003	0.003	0.003	0.003	0.003	0.003
45	0.004	0.004	0.001	0.002	0.001	0.001	0.002	95	0.003	0.001	0.004	0.004	0.002	0.001	0.004	145	0.003	0.003	0.003	0.003	0.003	0.003	0.003
46	0.002	0.004	0.003	0.003	0.003	0.001	0.001	96	0.002	0.004	0.005	0.005	0.004	0.002	0.001	146	0.003	0.003	0.003	0.003	0.003	0.003	0.003
47	0.004	0.002	0.002	0.005	0.004	0.005	0.002	97	0.004	0.003	0.002	0.001	0.001	0.005	0.003	147	0.003	0.003	0.003	0.003	0.003	0.003	0.003
48	0.002	0.002	0.004	0.003	0.003	0.001	0.002	98	0.001	0.001	0.004	0.005	0.003	0.002	0.001	148	0.003	0.003	0.003	0.003	0.003	0.003	0.003
49	0.002	0.004	0.003	0.004	0.001	0.002	0.002	99	0.003	0.004	0.004	0.004	0.002	0.002	0.001	149	0.005	0.001	0.001	0.005	0.001	0.003	0.003
50	0.003	0.001	0.004	0.001	0.005	0.004	0.002	100	0.003	0.005	0.004	0.001	0.004	0.004	0.001	150	0.001	0.002	0.001	0.002	0.005	0.002	0.004

© 2023The Authors

Table: 14: Proportion of the sample (Contd..)

S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7	S.No	EM1	EM2	EM3	EM4	EM5	EM6	EM7
151	0.004	0.002	0.001	0.001	0.001	0.005	0.001	201	0.004	0.004	0.002	0.005	0.003	0.004	0.001	251	0.005	0.005	0.005	0.005	0.005	0.005	0.005
152	0.001	0.003	0.005	0.002	0.003	0.003	0.004	202	0.001	0.003	0.004	0.004	0.002	0.003	0.005	252	0.005	0.005	0.005	0.005	0.005	0.005	0.005
153	0.003	0.002	0.004	0.004	0.005	0.003	0.005	203	0.004	0.004	0.003	0.004	0.002	0.005	0.004	253	0.005	0.005	0.005	0.005	0.005	0.005	0.005
154	0.003	0.003	0.003	0.003	0.003	0.003	0.003	204	0.004	0.004	0.004	0.004	0.004	0.004	0.004	254	0.005	0.005	0.005	0.005	0.005	0.005	0.005
155	0.003	0.003	0.003	0.003	0.003	0.003	0.003	205	0.004	0.004	0.004	0.004	0.004	0.004	0.004	255	0.005	0.005	0.005	0.005	0.005	0.005	0.005
156	0.003	0.003	0.003	0.003	0.003	0.003	0.003	206	0.004	0.004	0.004	0.004	0.004	0.004	0.004	256	0.005	0.005	0.005	0.005	0.005	0.005	0.005
157	0.003	0.003	0.003	0.003	0.003	0.003	0.003	207	0.004	0.004	0.004	0.004	0.004	0.004	0.004	257	0.005	0.005	0.005	0.005	0.005	0.005	0.005
158	0.003	0.003	0.003	0.003	0.003	0.003	0.003	208	0.004	0.004	0.004	0.004	0.004	0.004	0.004	258	0.005	0.005	0.005	0.005	0.005	0.005	0.005
159	0.003	0.003	0.003	0.003	0.003	0.003	0.003	209	0.004	0.004	0.004	0.004	0.004	0.004	0.004	259	0.005	0.005	0.005	0.005	0.005	0.005	0.005
160	0.003	0.003	0.003	0.003	0.003	0.003	0.003	210	0.004	0.004	0.004	0.004	0.004	0.004	0.004	260	0.005	0.005	0.005	0.005	0.005	0.005	0.005
161	0.003	0.003	0.003	0.003	0.003	0.003	0.003	211	0.004	0.004	0.004	0.004	0.004	0.004	0.004	261	0.005	0.005	0.005	0.005	0.005	0.005	0.005
162	0.003	0.003	0.003	0.003	0.003	0.003	0.003	212	0.004	0.004	0.004	0.004	0.004	0.004	0.004	262	0.005	0.005	0.005	0.005	0.005	0.005	0.005
163	0.003	0.003	0.003	0.003	0.003	0.003	0.003	213	0.004	0.004	0.004	0.004	0.004	0.004	0.004	263	0.005	0.005	0.005	0.005	0.005	0.005	0.005
164	0.003	0.003	0.003	0.003	0.003	0.003	0.003	214	0.004	0.004	0.004	0.004	0.004	0.004	0.004	264	0.005	0.005	0.005	0.005	0.005	0.005	0.005
165	0.003	0.003	0.003	0.003	0.003	0.003	0.003	215	0.004	0.004	0.004	0.004	0.004	0.004	0.004	265	0.005	0.005	0.005	0.005	0.005	0.005	0.005
166	0.003	0.003	0.003	0.003	0.003	0.003	0.003	216	0.004	0.004	0.004	0.004	0.004	0.004	0.004	266	0.005	0.005	0.005	0.005	0.005	0.005	0.005
167	0.003	0.003	0.003	0.003	0.004	0.003	0.003	217	0.004	0.004	0.004	0.004	0.004	0.004	0.004	267	0.005	0.005	0.005	0.005	0.005	0.005	0.005
168	0.003	0.003	0.003	0.004	0.004	0.003	0.003	218	0.004	0.004	0.004	0.004	0.004	0.004	0.004	268	0.005	0.005	0.005	0.005	0.005	0.005	0.005
169	0.003	0.003	0.003	0.004	0.004	0.003	0.003	219	0.004	0.004	0.004	0.004	0.004	0.004	0.004	269	0.005	0.005	0.005	0.005	0.005	0.005	0.005
170	0.003	0.003	0.003	0.004	0.004	0.003	0.003	220	0.004	0.004	0.004	0.004	0.004	0.004	0.004	270	0.005	0.005	0.005	0.005	0.005	0.005	0.005
171	0.003	0.003	0.003	0.004	0.004	0.003	0.003	221	0.004	0.004	0.004	0.004	0.005	0.004	0.004	271	0.005	0.005	0.005	0.005	0.005	0.005	0.005
172	0.003	0.003	0.003	0.004	0.004	0.003	0.003	222	0.004	0.004	0.004	0.004	0.005	0.004	0.004	272	0.001	0.001	0.001	0.005	0.001	0.002	0.001
173	0.003	0.003	0.003	0.004	0.004	0.003	0.003	223	0.004	0.004	0.004	0.004	0.005	0.004	0.004	273	0.004	0.005	0.002	0.002	0.002	0.003	0.002
174	0.003	0.003	0.003	0.004	0.004	0.003	0.003	224	0.004	0.004	0.004	0.005	0.005	0.004	0.004	274	0.005	0.003	0.003	0.005	0.005	0.005	0.003
175	0.003	0.003	0.003	0.004	0.004	0.003	0.003	225	0.004	0.004	0.004	0.005	0.005	0.004	0.004	275	0.002	0.004	0.003	0.003	0.001	0.004	0.004
176	0.003	0.004	0.003	0.004	0.004	0.004	0.003	226	0.004	0.004	0.004	0.005	0.005	0.004	0.004	276	0.001	0.001	0.001	0.003	0.004	0.001	0.001
177	0.003	0.004	0.003	0.004	0.004	0.004	0.003	227	0.004	0.005	0.004	0.005	0.005	0.004	0.004	277	0.004	0.003	0.002	0.004	0.001	0.001	0.003
178	0.004	0.004	0.003	0.004	0.004	0.004	0.003	228	0.004	0.005	0.004	0.005	0.005	0.004	0.004	278	0.004	0.003	0.001	0.005	0.004	0.005	0.005
179	0.004	0.004	0.003	0.004	0.004	0.004	0.003	229	0.004	0.005	0.004	0.005	0.005	0.004	0.004	279	0.002	0.004	0.001	0.004	0.004	0.001	0.005
180	0.004	0.004	0.003	0.004	0.004	0.004	0.003	230	0.004	0.005	0.004	0.005	0.005	0.004	0.004	280	0.002	0.001	0.002	0.005	0.003	0.004	0.004
181	0.004	0.004	0.003	0.004	0.004	0.004	0.003	231	0.004	0.005	0.004	0.005	0.005	0.005	0.004	281	0.003	0.001	0.005	0.005	0.001	0.001	0.002
182	0.004	0.004	0.003	0.004	0.004	0.004	0.004	232	0.004	0.005	0.004	0.005	0.005	0.005	0.004	282	0.004	0.002	0.004	0.001	0.001	0.001	0.001
183	0.004	0.004	0.003	0.004	0.004	0.004	0.004	233	0.004	0.005	0.004	0.005	0.005	0.005	0.004	283	0.001	0.005	0.002	0.001	0.003	0.002	0.004
184	0.004	0.004	0.004	0.004	0.004	0.004	0.004	234	0.004	0.005	0.004	0.005	0.005	0.005	0.005	284	0.005	0.002	0.002	0.001	0.001	0.005	0.004
185	0.004	0.004	0.004	0.004	0.004	0.004	0.004	235	0.005	0.005	0.004	0.005	0.005	0.005	0.005	285	0.002	0.003	0.001	0.005	0.002	0.002	0.002
186	0.004	0.004	0.004	0.004	0.004	0.004	0.004	236	0.005	0.005	0.004	0.005	0.005	0.005	0.005	286	0.001	0.003	0.004	0.004	0.004	0.001	0.001
187	0.004	0.004	0.004	0.004	0.004	0.004	0.004	237	0.005	0.005	0.005	0.005	0.005	0.005	0.005	287	0.001	0.005	0.003	0.001	0.003	0.001	0.003
188	0.004	0.004	0.004	0.004	0.004	0.004	0.004	238	0.005	0.005	0.005	0.005	0.005	0.005	0.005	288	0.001	0.005	0.005	0.005	0.004	0.005	0.003
189	0.004	0.004	0.004	0.004	0.004	0.004	0.004	239	0.005	0.005	0.005	0.005	0.005	0.005	0.005	289	0.001	0.003	0.002	0.003	0.005	0.001	0.002
190	0.004	0.004	0.004	0.004	0.004	0.004	0.004	240	0.005	0.005	0.005	0.005	0.005	0.005	0.005	290	0.003	0.001	0.003	0.003	0.003	0.005	0.001
191	0.004	0.004	0.004	0.004	0.004	0.004	0.004	241	0.005	0.005	0.005	0.005	0.005	0.005	0.005	291	0.001	0.001	0.002	0.004	0.004	0.002	0.002
192	0.004	0.004	0.004	0.004	0.004	0.004	0.004	242	0.005	0.005	0.005	0.005	0.005	0.005	0.005	292	0.003	0.002	0.003	0.001	0.003	0.002	0.004
193	0.004	0.004	0.004	0.004	0.004	0.004	0.004	243	0.005	0.005	0.005	0.005	0.005	0.005	0.005	293	0.004	0.005	0.004	0.005	0.001	0.003	0.003
194	0.004	0.004	0.004	0.004	0.004	0.004	0.004	244	0.005	0.005	0.005	0.005	0.005	0.005	0.005	294	0.002	0.001	0.003	0.005	0.002	0.005	0.005
195	0.004	0.004	0.004	0.004	0.004	0.004	0.004	245	0.005	0.005	0.005	0.005	0.005	0.005	0.005								
196	0.004	0.004	0.004	0.004	0.004	0.004	0.004	246	0.005	0.005	0.005	0.005	0.005	0.005	0.005								
197	0.004	0.004	0.004	0.004	0.004	0.004	0.004	247	0.005	0.005	0.005	0.005	0.005	0.005	0.005								
198	0.004	0.004	0.004	0.004	0.004	0.004	0.004	248	0.005	0.005	0.005	0.005	0.005	0.005	0.005								
199	0.001	0.002	0.005	0.005	0.003	0.001	0.001	249	0.005	0.005	0.005	0.005	0.005	0.005	0.005								
200	0.005	0.004	0.001	0.002	0.001	0.004	0.001	250	0.005	0.005	0.005	0.005	0.005	0.005	0.005								

© 2023The Authors

4.3.3 Entropy value of the Criteria: Entropy values and relative weights of the criteria are determined as discussed in section 2.3 and the values are presented in the following table.

Table 15: Relative weights of the Criteria

Criteria	EM1	EM2	EM3	EM4	EM5	EM6	EM7
Entropy	-5.6034	-5.6081	-5.5971	-5.6040	-5.5915	-5.5836	-5.6047
Relative Weight	0.1430	0.1431	0.1428	0.1430	0.1427	0.1425	0.1430

Similarly, the relative weights of the criteria of tangibles (TA), Safety (SA), Efficiency (EF), Degree of improvement (DI) and Operational Performance (OP) are determined and presented in the following table.

Table 13: Relative weights of the criteria (ENTROPY Method)

Criteria	Rel.Wt	Criteria	Rel.Wt
EM1	0.1430	EF1	0.1632
EM2	0.1431	EF2	0.1694
EM3	0.1428	EF3	0.1703
EM4	0.1430	EF4	0.1664
EM5	0.1427	EF5	0.1682
EM6	0.1425	EF6	0.1625
EM7	0.1430	DI1	0.1248
TA1	0.1995	DI2	0.1250
TA2	0.2002	DI3	0.1252
TA3	0.2001	DI4	0.1250
TA4	0.2002	DI5	0.1250
TA5	0.1999	DI6	0.1247
SA1	0.1668	DI7	0.1252
SA2	0.1667	DI8	0.1250
SA3	0.1668	OP1	0.1997
SA4	0.1668	OP2	0.2003
SA5	0.1667	OP3	0.2001
SA6	0.1662	OP4	0.1997
		OP5	0.2001

© 2023The Authors

4.4 Comparison of Relative weights by the Proposed Methods: relative weights of the proposed methods are presented in table 14.

Table 14: Ranking of the criteria by the Proposed methods

Criteria	Ranks			Criteria	Ranks		
	CRITIC	MEREC	ENTROPY		CRITIC	MEREC	ENTROPY
EM1	25	26	26	EF1	15	21	21
EM2	29	24	23	EF2	20	12	12
EM3	27	29	27	EF3	11	18	11
EM4	24	23	25	EF4	23	11	19
EM5	22	27	28	EF5	13	15	13
EM6	30	28	29	EF6	21	22	22
EM7	26	25	24	DI1	28	36	36
TA1	2	10	10	DI2	31	34	32
TA2	5	3	3	DI3	35	31	31
TA3	10	5	4	DI4	34	33	33
TA4	3	2	2	DI5	36	35	34
TA5	4	8	7	DI6	33	32	37
SA1	16	17	16	DI7	37	30	30
SA2	17	20	17	DI8	32	36	35
SA3	18	14	14	OP1	9	9	9
SA4	19	19	15	OP2	6	1	1
SA5	12	16	18	OP3	8	4	5
SA6	14	13	20	OP4	1	6	8
				OP5	7	7	6

The CRITIC method prioritizes Length of Stay (OP4) as the most important criterion followed by (Degree of securing advanced medical equipment's(TA1), Degree of cleanliness of employees (TA4), Overall cleanliness of hospital (TA5) and Degree of securing medical staff with skill and advanced knowledge(TA2) for improving health care service quality. Degree of patient improved condition after hospital care (DI4), Improvement in cure of the disease (DI7) and improvement in medical condition(DI3) are given relatively lower priorities.

The MEREC method is an evolutionary algorithm-based approach that constructs an ensemble of rule-based classifiers to optimize multiple objectives. In this case, we can assume that the objectives for health care quality improvement are reducing medication errors, minimizing hospital-acquired infections, and enhancing care coordination. The priorities obtained by the MEREC method could be OP2 followed by Degree of cleanliness of employees (TA4), and Degree

© 2023The Authors

of securing medical staff with skill and advanced knowledge (TA2), Loyalty of the patients (OP3) and Degree of convenient facilities (TA3)

The entropy method assigns the highest priority to waiting time of the patients (OP2) followed by Degree of cleanliness of employees (TA4), Degree of securing medical staff with skill and advanced knowledge (TA2), Degree of convenient facilities (TA3) and Loyalty of the patients (OP3) indicating that improving patient health outcomes should be the primary focus for enhancing health care quality.

Comparison of rankings of criteria by the proposed method is presented in matrix plot shown in figure 1.

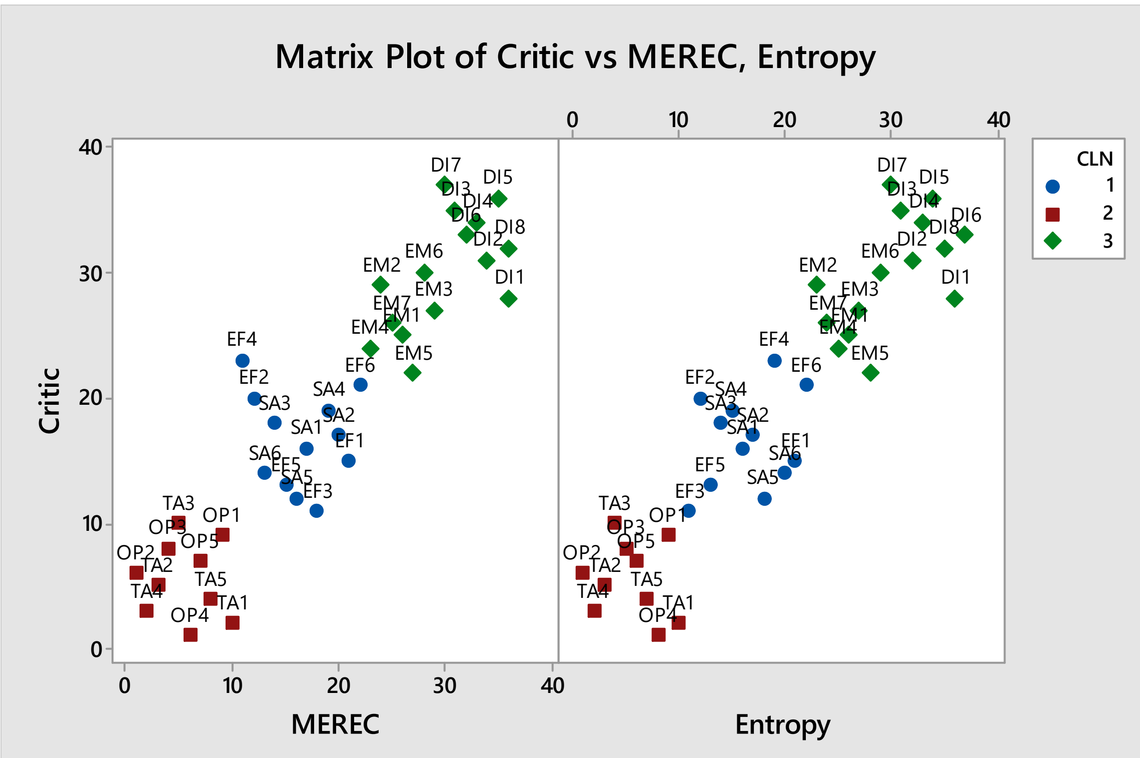

Figure 1: matrix plot of relative ranking of Criteria by the proposed methods.

From the matrix plot it is observed that Cluster 1 contains the criteria namely: TA1, TA2, TA3, TA4, TA5, OP1, OP2, OP3, OP4 and OP5 indicates that these criteria are showing highest importance for healthcare service quality.

Cluster 2 contains the criteria namely: EM1, EM2, EM3, EM4, EF5, EF6 SA1, SA2, SA3, SA4, SA5and SA6 indicates that these criteria are showing medium importance for healthcare service quality.

© 2023The Authors

Cluster 3 contains the criteria namely: EF1, EF2, EF3, EF4, EF5, EF6 SA1, SA2, SA3, SA4, SA5and SA6 indicates that these criteria are showing medium importance for healthcare service quality

4.5 Correlation of rankings: Correlations of Weights by the proposed Methods is analyzed and correlation coefficients are presented in table 15. From the correlation analysis it is observed that there exists strong and positive correlation in the relative weights of the criteria obtained by the proposed methods since correlation coefficients among methods are high with p value <=0.01

Table 15: Correlation analysis

Method	CRITIC	MEREC	ENTROPY
CRITIC	1.000	0.913 (p-0.000)	0.922 (p=0.000)
MEREC	0.913 (p-0.000)	1.000	0.971 (p=0.000)
ENTROPY	0.922 (p=0.000)	0.971 (p=0.000)	1.0000

4.6 Aggregation of Weights: In this paper, The three-point estimation (Optimistic weight, Mostlikely weight and Pessimistic weight) technique is used to aggregate the weights of the criteria for healthcare service quality obtained through the proposed methods.

Table 16: Final weights of the Healthcare quality criteria

Criteria	To	Tm	Tp	Agg. Weight
EF1	0.1618	0.1650	0.1701	0.1653
EF2	0.1599	0.1670	0.1717	0.1666
EF3	0.1656	0.1718	0.1795	0.1720
EF4	0.1531	0.1642	0.1730	0.1638
EF5	0.1677	0.1713	0.1781	0.1719
EF6	0.1594	0.1607	0.1625	0.1608
DI1	0.1217	0.1284	0.1385	0.1289
DI2	0.1240	0.1250	0.1259	0.1250
DI3	0.1224	0.1255	0.1289	0.1255
DI4	0.1228	0.1244	0.1253	0.1243
DI5	0.1218	0.1233	0.1250	0.1233

© 2023The Authors

DI6	0.1234	0.1245	0.1254	0.1245
DI7	0.1200	0.1249	0.1296	0.1249
DI8	0.1217	0.1240	0.1252	0.1238
OP1	0.1883	0.1940	0.1997	0.1940
OP2	0.1968	0.2026	0.2107	0.2030
OP3	0.1948	0.2001	0.2055	0.2001
OP4	0.1982	0.2052	0.2177	0.2061
OP5	0.1967	0.1980	0.2001	0.1981

5.0 CONCLUDING REMARKS

In conclusion, the CRITIC, MEREC, and Entropy methods provide different perspectives on the priorities for improving health care quality. Each method offers a unique approach to decision-making, considering various criteria and objectives. Here are some concluding remarks and future scope for these methods. The CRITIC method prioritizes criteria based on their intercriteria correlation. It offers insights into the relative importance of different criteria and helps identify areas that require immediate attention. The MEREC method provides a comprehensive understanding of factors' importance in healthcare improvement. Entropy method offers a mathematical approach to decision-making and provides a clear ordering of priorities.

Overall, these methods provide valuable insights into the priorities for improving health care quality. However, it is important to recognize that no single method can capture the complexity and nuances of health care quality improvement fully. Integrating multiple methods, involving domain experts, and considering contextual factors are crucial for developing comprehensive and effective strategies to enhance health care quality. Future research should aim to refine and validate these methods further, considering the evolving nature of health care and the changing expectations of patients and stakeholders.

REFERENCES

1. Abeer Hadi and Mahmood Zaki Abdullah (2022), Web and IoT-based hospital location determination with criteria weight analysis, Bulletin of Electrical Engineering and Informatics Vol. 11, No. 1, pp. 386-395,DOI: 10.11591/eei.v11i1.3214
2. Aihua Li, Diwen Wang and Meihong Zhu (2020), Service evaluation through FH-entropy method: A framework for the elderly care station, Concurrency Computat. Pract. Exper., pp. 1- 14, https://doi.org/10.1002/cpe.6045
3. Ali Reza Afshari and Mahmood Khorsand (2020), Application of Multi Criteria Decision Making in Health Care, X International Symposium Engineering Management and Competitiveness 2020 (EMC 2020) 19-20th June, Zrenjanin, Serbia, pp.1-8
4. Amr A. Hassanain , MohamedA.A. Eldosoky & Ahmed M. Soliman (2022), Evaluating building performance in healthcare facilities using entropy and graph heuristic theories,

© 2023The Authors

Scientifc Reports, Vol. 12, No.8973, pp.1-16, https://doi.org/10.1038/s41598-022-13004-8

5. Anath Rau Krishnan,Maznah Mat Kasim,Rizal Hamid and Mohd Fahmi Ghazali (2021), A Modified CRITIC Method to Estimate the Objective Weights of Decision Criteria, Symmetry ,Vol. 13,No.6, pp.1-15, https://doi.org/10.3390/sym13060973
6. Banik B, Alam S, Chakraborty A (2023), Comparative study between GRA and MEREC technique on an agricultural-based MCGDM problem in pentagonal neutrosophic environment., Int J Environ Sci Technol (Tehran) pp.1-16. doi: 10.1007/s13762-023-04768-1
7. Eiseman NA, Bianchi MT, Westover MB. The information theoretic perspective on medical diagnostic inference. Hosp Pract (1995). 2014, Vol.42, No.2:pp.1-25, doi: 10.3810/hp.2014.04.1110. PMID: 24769791; PMCID: PMC6993929
8. Khan I, Pintelon L and Martin H (2022), The Application of Multicriteria Decision Analysis Methods in Health Care: A Literature Review, Medical Decision Making, Vol.42, No.2,pp.262-274. doi:10.1177/0272989X211019040
9. Mališa Žižović, Boža Miljković and Dragan Marinković (2020), Objective methods for determining criteria weight coefficients: A modification of the CRITIC method, Decision Making: Applications in Management and Engineering, Vol. 3, No. 2, https://doi.org/10.31181/dmame2003149z
10. Mehdi Keshavarz-Ghorabaee,Maghsoud Amiri, Edmundas Kazimieras Zavadskas, Zenonas Turskis and Jurgita Antucheviciene (2021), Determination of Objective Weights Using a New Method Based on the Removal Effects of Criteria (MEREC), Symmetry, Vol. 13, No.4, pp.1-20, https://doi.org/10.3390/sym13040525,
11. Miao R, Xiang X, Wu Q, Jiang Z (2020), Evaluation method of medical service system based on DEMATEL and the information entropy: A case study of hypertension diagnosis and treatment in China, PLoS ONE, Vol.15, No.12, pp.1-15, https://doi.org/10.1371/journal.pone.0243832
12. MOMČILO D. VUJIČIĆ, MILOŠ Z. PAPIĆ and MARIJA D. BLAGOJEVIĆ (2017), Comparative Analysis of Objective Techniques for Criteria Weighing in Two MCDM Methods on Example of an Air Conditioner Selection, TEHNIKA – MENADŽMENT, Vol. 67,No 3, pp.422-429
13. Mukhametzyanov, I. (2021), Specific character of objective methods for determining weights of criteria in MCDM problems: Entropy, CRITIC and SD. Decision Making: Applications in Management and Engineering, Vol.4,No.2,pp. 76–105. https://doi.org/10.31181/dmame210402076i
14. Nuh Keles (2023), Measuring performances through multiplicative functions by modifying the MEREC method: MEREC-G and MEREC-H, International Journal of Industrial Engineering and Operations Management, Vol.12, pp.1-19,DOI 10.1108/IJIEOM-12-2022-0068

© 2023The Authors

15. Raman Kumar, Sehijpal Singh, Paramjit Singh Bilga, Jatin, Jasveer Singh, Sunpreet Singh, Maria-Luminit, Scutaru and alin Iulian Pruncu (2021), Journal of materials research and technology, Vol.10, pp.1471-1492
16. Shen Y, and Liao K (2022), An Application of Analytic Hierarchy Process and Entropy Weight Method in Food Cold Chain Risk Evaluation Model. Front Psychol, Vol. 19, No.825696, pp.1-19, doi: 10.3389/fpsyg.2022.825696. PMID: 35519628; PMCID: PMC9062984.
17. Trung, D.D. and Thinh, H.X (2021), A multi-criteria decision-making in turning process using the MAIRCA, EAMR, MARCOS and TOPSIS methods: A comparative study, Advances in Production Engineering & Management,Vol. 16,No.4,pp.443–456, https://doi.org/10.14743/apem2021.4.412
18. Xindong Peng, R. Krishankumar, and K. S. Ravichandran, "A novel interval-valued fuzzy soft decision-making method based on CoCoSo and CRITIC for intelligent healthcare management evaluation", Soft Computing, vol. 25, no. 6, pp. 4213 - 4241, 2021.
19. Yuxin Zhu, Dazuo Tian and Feng Yan (2020), Effectiveness of Entropy Weight Method in Decision-Making, Mathematical Problems in Engineering Volume 2020, No.3564835, pp.1-5, https://doi.org/10.1155/2020/3564835
20. Zhou, Rongxi, Liu, Shancun and Qiu, Wanhua. (2008). Survey of applications of entropy in decision analysis. Control and Decision, Vol. 23, No.4

© 2023The Authors