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Academic Staff Selection Using Fuzzy VIKOR and Fuzzy TOPSIS Decision Making Method

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Abstract: *The decision-making method is a process for selecting the optimal preference based on the available evidence. The process involves selecting several qualified individuals from an academic institution based on criteria such as academic qualifications, experience, anticipated salary, topic proficiency, research activities, technical skills, and communication abilities. Such selections can be unclear and difficult to define within the multi-criteria decision-making process. The VIKOR technique establishes a compromise ranking list, identifies a compromise solution, and assesses weight stability, concentrating on the ranking and selection of alternatives for academic data. VIKOR and TOPSIS can analyze the selections, and TOPSIS can rank candidates based on their academic performance. This research presents a comparative analysis of alternative rankings utilizing VIKOR and TOPSIS for various competent individuals within an academic institution.*

Keywords*:* MDCM, Entropy Method, VIKOR, TOPSIS

I. INTRODUCTION

In the competitive society of today, the choice of a competent individual for any academic institution is a significant instrument of the decision-making process. The decision-making process is a means of selecting optimum preferences for the provided data. An academic institution selects several competent individuals based on their performance, which includes factors such as qualifying marks, experience, expected salary, capacity to manage multiple subjects, research activities, technical skills, and presentation/communication skills. Under the multi-criteria decision-making approach, such selections are unclear and imprecise. Here, the VIKOR technique emphasizes the ranking and selection of alternatives for the academic data and defines the compromise ranking list, compromise solution, and weight stability system. These selections can be shown via VIKOR and TOPSIS; TOPSIS is the technique of selecting the order of preference for the academic performance of the candidate.

Multi-criteria decision making (MCDM) is a prominent subject within the field of decision making. Fuzzy logic offers a valuable framework for addressing MCDM challenges, particularly when data is imprecise and ambiguous. In real-world decision contexts, traditional MCDM methods may encounter significant practical limitations due to the inherent imprecision or vagueness of the criteria involved. To address these issues, fuzzy multi-attribute decision-making (MADM) and fuzzy multi-objective decision-making (MODM) methodologies have been established. The decision-making process entails selecting an alternative from a range of viable actions based on various factors determined by the decision makers. This process becomes increasingly complex when multiple criteria are involved. The MADM approach highlights outcomes related to conflicting criteria, such as cost and benefit considerations.

A method called Vlse kriterijumska optimizacija kompromisno rešenje (VIKOR) was created to help with the multi-criteria optimization of complicated systems. It establishes the compromise ranking list, the compromise solution, and the weight stability intervals for the preference stability of the compromise solution derived from the initial weights provided. This approach emphasizes the evaluation and selection of alternatives amidst conflicting criteria. It presents the multi-criteria ranking index predicated on the specific metric of “closeness” to the “ideal” answer.

Provided that each alternative is assessed based on each criterion function, the compromise ranking may be executed by analyzing the proximity to the ideal alternative. The multi-criteria measure for compromise ranking is derived from the

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Lp-metric aggregation function in the compromise programming method. (Yu 1973; Zeleny 1982). The distinct k-alternatives (k=1,2,...,n) are represented as a $a_{1,}a_{2,...,}a_n$. For alternatives ak, the evaluation of the j^{th} criterion/aspect is represented by f_{kj}. Specifically, f_{kj} denotes the value of the j^{th} criterion function for the alternative a_k; m represents the number of criteria (j=1,2,...,m).

Opricovic introduced the VIKOR approach in 1998 for the multi-attribute optimization of complex systems. The method emphasizes the compromise ranking list, the compromise solution, and the interval of strategic weights for the preferred option. It is predicated on the multi-criteria ranking index, which quantifies proximity to the optimal answer.

TOPSIS says that the chosen option should be as close to the ideal solution as possible and as far away from the negative ideal solution as possible. Any option's superior performance metrics for each attribute constitute the optimal solution. The negative ideal solution comprises the aggregate of the least favorable performance values. The Euclidean metric is used to measure how close each performance pole is. This is the square root of the sum of the squared distances along each axis in the attribute space. Each attribute can have a weight added to it. TOPSIS conceptualizes a multi-attribute decision-making (MADM) problem with several choices as a geometric framework

Hwang and Yoon created this strategy in 1981. The strategy relies on the principle that the selected option must possess the minimal distance from the negative ideal answer. TOPSIS establishes an index that measures the proximity to the positive ideal solution and the distance from the negative ideal solution. The approach selects an option that has the highest similarity to the positive ideal solution.

II. LITERATURE REVIEW

Multi-criteria decision making (MCDM) has become an essential method for addressing intricate decision-making issues that involve numerous conflicting criteria. Diverse methodologies have been established over time, each presenting distinct benefits contingent upon the decision-making situation. Among these, ARAS (Additive Ratio Assessment), MOORA (Multi-Objective Optimization by Ratio Analysis), and the Preference Selection Index (PSI) have received considerable attention.

The first important steps toward creating MCDM methods were taken by Hwang and Yoon [5], who carefully examined different methods for making decisions based on multiple attributes. Their work made it easier for the field to move forward. Colson and De Bruyn [3] conducted an in-depth examination of models and methodologies, providing an expanded viewpoint on MCDM applications.

Recently, ARAS has been utilized in various domains, demonstrating its effectiveness in decision-making contexts that necessitate the ranking of alternatives based on performance metrics. Mousavi-Nasab and Sotoudeh-Anvari [6] used ARAS along with other MCDM techniques like TOPSIS and COPRAS to solve problems with material selection. This showed how strong and flexible the method is.

MOORA has been widely employed owing to its computational simplicity and efficacy in managing various objectives. Researchers Yazdani, Zolfani, and Zavadskas [12] used MOORA along with other MCDM methods to find environmentally friendly suppliers. This showed that it works well for meeting sustainability needs. The Preference Selection Index (PSI) method has become more popular as a simple yet effective instrument for assessing alternatives in the presence of many criteria. Despite the scarcity of direct studies on PSI, its amalgamation with other MCDM methodologies signifies its increasing significance in improving decision-making processes.

Also, many studies have looked into how fuzzy logic can help make MCDM methods better at reducing the uncertainty that comes with making decisions. Awasthi, Chauhan, and Goyal [1] utilized fuzzy MCDM methodologies to analyze suppliers' environmental performance, whereas Govindan, Khodaverdi, and Jafarian [4] implemented a comparable fuzzy framework to evaluate sustainability performance.

The juxtaposition and amalgamation of diverse MCDM methodologies have been a persistent motif in the literature. Opricovic and Tzeng [7, 8] performed comparative evaluations of methodologies such as VIKOR and TOPSIS, elucidating their relative efficacy. Sanayei, Mousavi, and Yazdankhah [10] utilized fuzzy VIKOR in group decision-making for supplier selection, hence enhancing the method's applicability.

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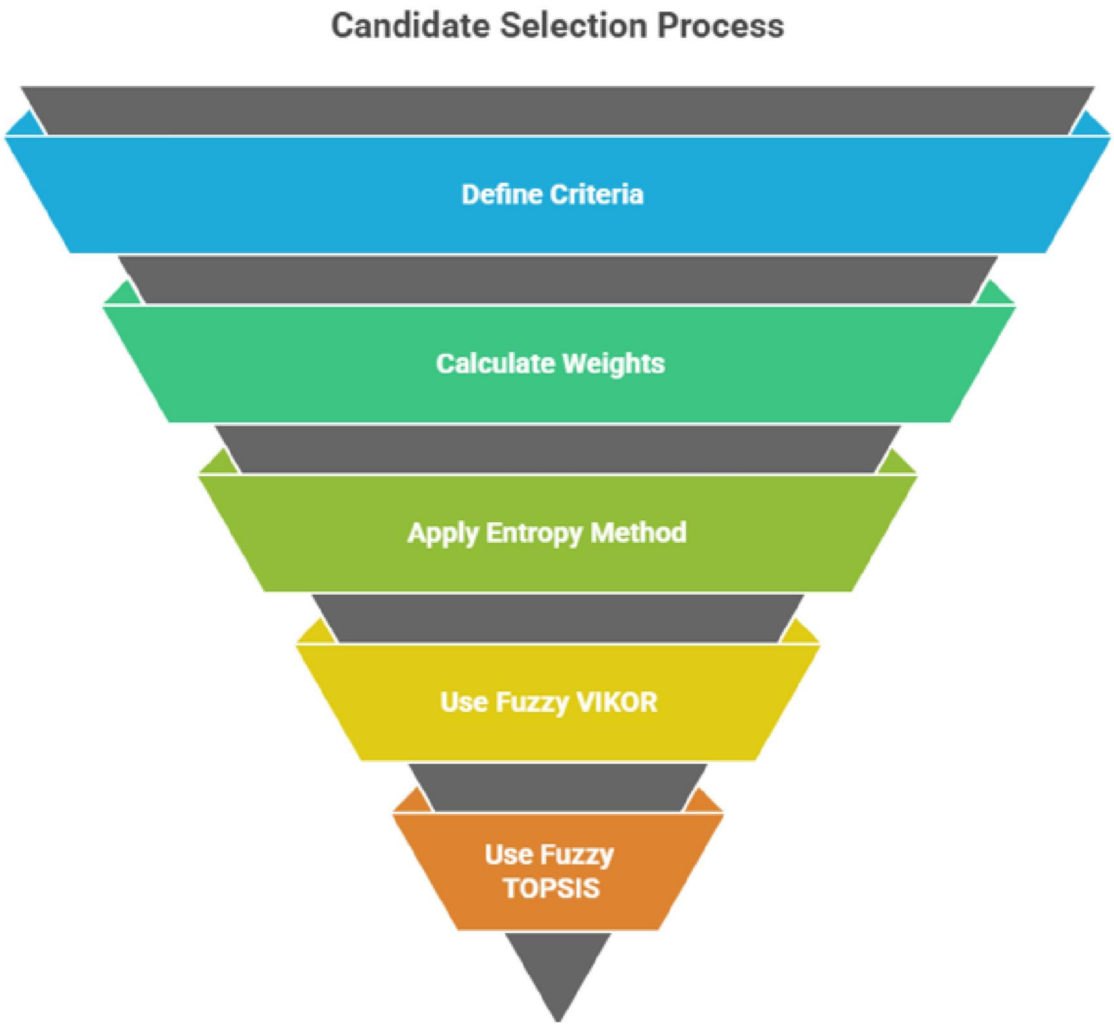

Fig:1 Flow chart shows that the whole methodology of the article.

III. METHODOLOGY

3.1. Entropy Method

An unbiased weighting, Entropy, method introduced by Shannon [26] in 1948, is a technique used to assign weights to decision criteria based on their relative importance and variability. It measures the degree of uncertainty associated with each criterion and assigns higher weights to those with lower Entropy values, indicating greater consistency.

i) Calculate the projection value of each criteria is given by,

$$P_{kj} = \frac{f_{kj}}{\sum_{k=1}^{m} f_{kj}}, \text{ k = 1, 2, …, n.}$$

ii) Calculate the Entropy values are computed by using the following expression,

$$E_j = -c \sum_{k=1}^{m} P_{kj} \log(P_{kj}), \text{ k = 1, 2, …, m and j = 1, 2, …,n.}$$

Where c = $(\log(m))^{-1}$ is a constant.

iii) Determine the degree of divergence d_j for each criteria

$$d_j = 1 - E_j, \text{ j = 1, 2, …, n.}$$

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iv) Calculate the weight for each criteria are obtained as

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_\beta}, \text{ j = 1,2,…,n.}$$

3.2. The VIKOR method

i) Determine the best f_j^* and the worst f_j^- values of all criterion functions,j=1,2,...,n. If the j^{th} function represent a benefit then $f_j^* = max_k f_{kj}$ or setting f_j^* is the aspired / desired level ,$f_j^- = min_k f_{kj}$ or setting f_j^- is the worst level.

ii) Compute the value S_k and R_k,k=1,2,...,m by the relations .

$$S_k = \sum_{j=1}^{m} wj \frac{|f_j^* - f_{kj}|}{|f_j^* - f_j^-|},$$

$$R_k = \max\{\frac{|f_j^* - f_{kj}|}{|f_j^* - f_j|}\} \text{ k=1,2,...m, j=1,2,...,n.}$$

iii) Compute the values Q_k, k=1,2,...,m by the relation

$$Q_k = \mho \frac{(S_k - S^*)}{(S^- - S^*)} + (1-\mho)\frac{(R_k - R^*)}{(R^- - R^*)} \text{ , k=1,2,...,m (alternatives).}$$

$\mho$ is introduced as the weight of the strategy of " the majority of criteria" or " the maximum group utility" ,here $\mho$=0.5.

iv) Rank the alternatives, sorting by the values S, Rand Q, in decreasing order .The result are there ranking lists.

v)Propose as a compromise solution the alternative (a'),which is ranked the best by the measure Q(minimum) if the following two condition are satisfied .

C_1 : "Acceptableadvantage "

$$Q(\mu'') - Q(\mu') \geq DQ$$

Where a'' is the alternative with second position in the ranking list by Q^- ,DQ =$\frac{1}{(J-1)}$ and J is the number of alternatives .

C_2 : "Acceptable stability in decision making"

Alternative a'must also be the best ranked by **S** or / and **R.** This compromise solution is stable within a decision making process , which could be, " voting by majority rule" (when $\mho > 0.5$ is $needed$), "by consensus " $\mho \approx 0.5$ or "with vote" ($\mho < 0.5$) . Here, $\mho$ is the weight of the decision making strategy " the majority of criteria "(or "the maximum group utility").

If one of the condition is not satisfied, the a set of compromise solution is proposed, which consist of ;

Alternatives a' and a'' if only conditionC_2 is not satisfied ,or

Alternatives $a', a'', \dots, a^{(n)}$ if $condition$ C_1 is not satisfied;and ($a^{(n)}$) is determined by the relation Q($a^{(n)} - Q(a')$) $< DQ$ for maximum n (the position of those alternatives are "in closeness")

The best alternatives, ranked by Q, is the one with the minimum value of Q. The main ranking result is the compromise making list of alternatives and the compromise solution with the "advantage rate".

3.3 The TOPSIS method

i) $r_{kj}(x) = \frac{x_{kj}}{\sqrt{\sum_{k=1}^{n} x_{kj}^2}}$, k=1,2,...,m; j=1,2,...,n

ii) For benefit criteria (large is better) , $r_{kj} = \frac{(x_{kj} - x_j^-)}{(x_j^* - x_j^-)}$

where $x_j^* = \max_k x_{kj}$ and $x_j^- = \min_k x_{kj}$ or setting is the aspired / desired level and x_j^- is the worst level.

For cost criteria (smaller is better),$r_{kj}(x) = \frac{x_j^- - x_{kj}}{x_j^- - x_j^*}$ and then to calculate weighted normalized rating by $V_{kj}(x) = W_j r_{kj}(x)$, k=1,2,...,m; j=1,2,...,n.

Next the positive ideal point (PIS) and the negative ideal point (NIS) are derived as ,

$$\text{PIS} = A^+ = \{(\max V_{kj}(x))\}$$

$$\text{NIS} = A^- == \{(\min_k V_{kj}(x))\}$$

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The next step is to calculate the separation from the PIS and the NIS between alternatives. The separation values can be measured using the Euclidean distance, which is given as

$$D_k^* = \sqrt{\sum_{j=1}^{m}[v_{kj}(x) - v_j^+(x)]^2} \text{ , k= 1, 2,...,m. ;j=1,2,...,n.}$$

$$D_k^- = \sqrt{\sum_{j=1}^{m}[v_{kj}(x) - v_j^-(x)]^2} \text{ , k= 1 , 2,...,m;j=1,2,...,n.}$$

The similarities to the PIS can be derived as

$$C_k^* = \frac{D_k^*}{(D_k^* + D_k^-)} \text{ , k=1, 2,...,m}$$

Finally, the preferred orders can be obtained according to the similarities to the PIS (C_k^*) in descending order to choose the best alternatives.

IV. SELECTION OF ACADEMIC STAFF

Let us consider the problem of selecting a staff in a academic institution for the post of Assistant professor is a high priority for a students in the todays world .These institution use different criteria's , communication, patience, Time management, Qualification , Experience ,ability to handle different subjects, leadership, creativity, Research activeties, Technical skill, critical thinking ,team work, and so on. Now we are assuming, the management will select seven criteria for a qualified persons . That include C_1=Qualification marks, C_2=Experience in year, C_3=Expecting salary per /month, C_4=Ability to handle different subjects, C_5=Research activities, C_6=Technical skill and C_7=Presentation/Communication skill. Hence the criteria C_1, C_2, C_4, C_5, C_6, C_7 are benefit typecriteria whereas criteria C_3 is cost type criteria. The information sorted from the applicationsfor the post of Assistant Professor is given in table 1 and the rating for the qualification, technical skill , communication skill given in table 2.The steps that are involved in the articleare given below.

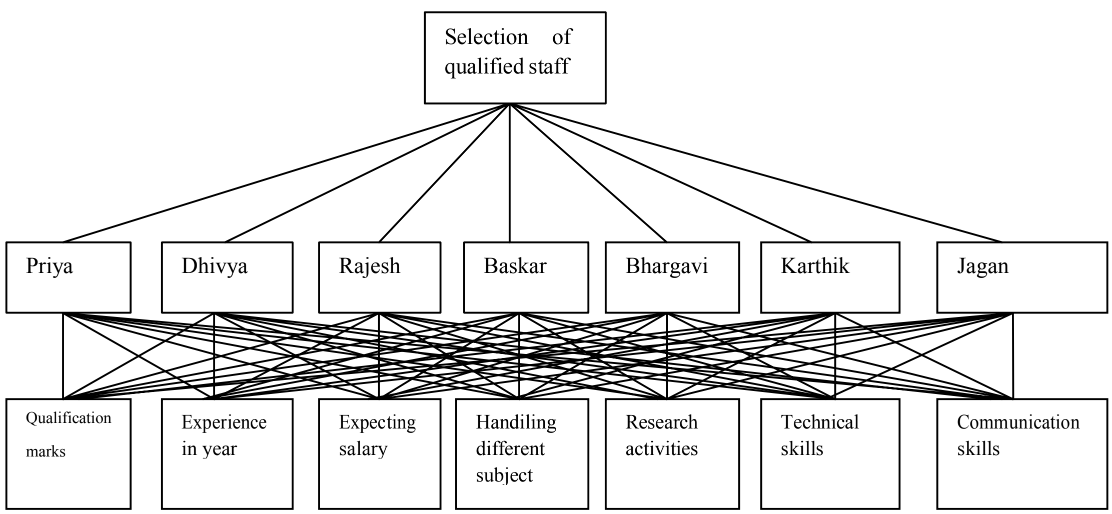

Fig:2 Flow chart shows the selection of qualified persons

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TABLE:1 Educational details for candidates

S.NO	Name of applicant	Qualification marks	Experience in year	Expecting salary per/month	Ability to handle different subject	Research activities	Technical skills	Communication skill
1	Priya	M.BA	2	25,000	4	3	Above average	Good
2	Dhivya	Pusuing Ph.D	6	30,000	6	4	Average	Above average
3	Rajesh	MCA	4	40,000	5	3	Above average	Average
4	Baskar	M.Tech	3	20,000	3	5	Below average	Poor
5	Bhargavi	Ph.D	12	45,000	8	9	Excellent	Below average
6	Karthik	Pursuing Ph.D	8	35,000	7	4	Good	Average
7	Jagan	B.Tech	2	15,000	2	2	Poor	Below average

TABLE:2 Linguistic value for the above table

Qualification	**Technical skill**	**Communication skill**	**Rating for different criteria**
B.Tech	Poor	Poor	5
M.Tech	Below average	Below average	6
MBA	Average	Average	7
MCA	Above average	Above average	8
Pursuing Ph.D	Good	Good	9
Ph.D	Excellent	Excellent	10

TABLE:3 Combosition of Rating

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SI. NO	**Criteria**	**Qualification mark**	**Experience in year**	**Salary expecting month**	**Ability to perhandle different subject**	**Research activities(No.of paper published)**	**Technical skill**	**Presentation skill/Communication skill**
1	Priya	7	2	25,000	4	3	8	9
2	Dhivya	9	6	30,000	6	4	7	8
3	Rajesh	8	4	40,000	5	3	8	7
4	Baskar	6	3	20,000	3	5	6	5

5	Bhargavi	10	12	45,000	8	9	10	6
6	Karthik	9	8	35,000	7	4	9	7
7	Jagan	5	2	15,000	2	2	5	6

TABLE:4 Normalized fuzzy Decision matrix

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Priya	0.7	0.1666	0.6	0.5	0.3333	0.8	1.00
Dhivya	0.9	0.5	0.5	0.75	0.4444	0.7	0.8888
Rajesh	0.8	0.3333	0.375	0.625	0.3333	0.8	0.7777
Baskar	0.6	0.25	0.75	0.375	0.5555	0.6	0.5555
Bhargavi	1.00	1.00	0.3333	1.00	1.0	1.00	0.6666
Karthik	0.9	0.6666	0.428	0.875	0.4444	0.9	0.7777
Jagan	0.5	0.1666	1.00	0.25	0.2222	0.5	0.6666

TABLE:5 VIKOR RankingValues of S_k, R_k , $and\ Q_k$

S_k	**Ranking**	R_k	**Ranking**	Q_k	**Ranking**
0.5829	5	0.1759	4	0.4782	4
0.5324	4	0.2639	5	0.5560	5
0.4982	3	0.1759	3	0.4350	3
0.77	6	0.3519	6	0.7807	6
0.0153	1	0.0153	1	0.0	1
0.302	2	0.1392	2	0.2919	2
0.9969	7	0.4399	7	1.00	7

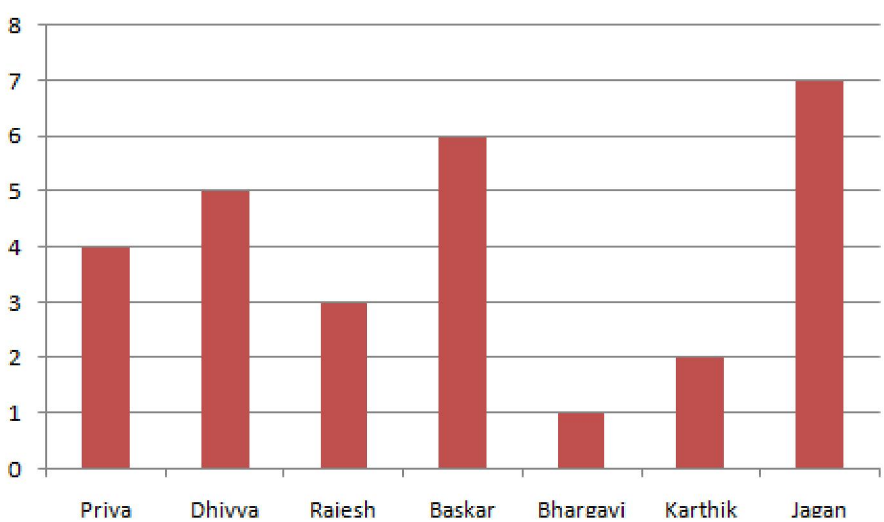

Fig:3 Graphical representation of VIKOR method

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Table:6 Ranking value of Fuzzy TOPSIS

D_k^*	Ranking	D_k^-	Ranking	C_k^*	Ranking
0.1140	3	0.0767	5	0.4022	5
0.1040	5	0.0797	4	0.4338	4
0.1080	4	0.0889	3	0.4514	3
0.1240	2	0.0557	6	0.3099	6
0.0050	7	0.1752	1	0.9700	1
0.0816	6	0.1161	2	0.5872	2
0.1752	1	0.00	7	0.0	7

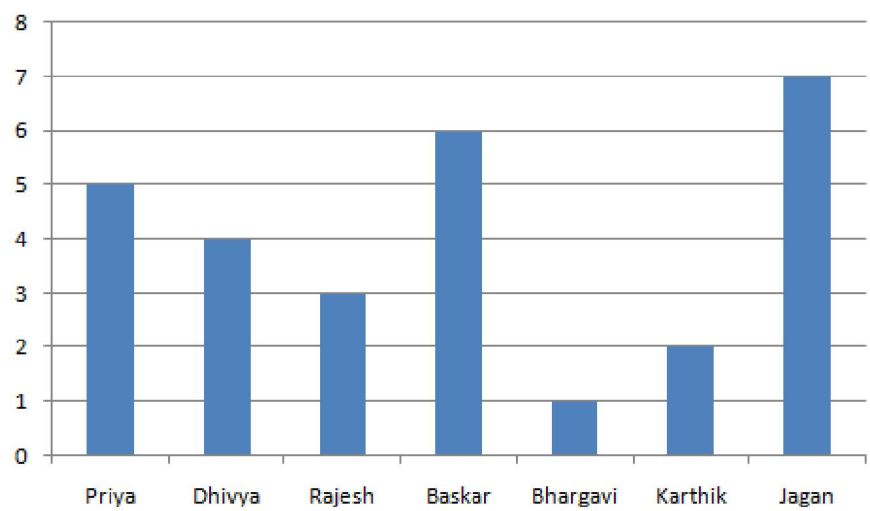

Fig:4 Graphical representation of TOPSIS method

Table 7: Comparison of Fuzzy VIKOR and Fuzzy TOPSIS

Name of applicant	VIKOR	Ranking of VIKOR	TOPSIS	Ranking of TOPSIS
Priya	0.4782	4	0.4022	5
Dhivya	0.5560	5	0.4338	4
Rajesh	0.4350	3	0.4514	3
Baskar	0.7807	6	0.3099	6
Bhargavi	0.0	1	0.9700	1
Karthik	0.2919	2	0.5872	2
Jagan	1.00	7	0.0	7

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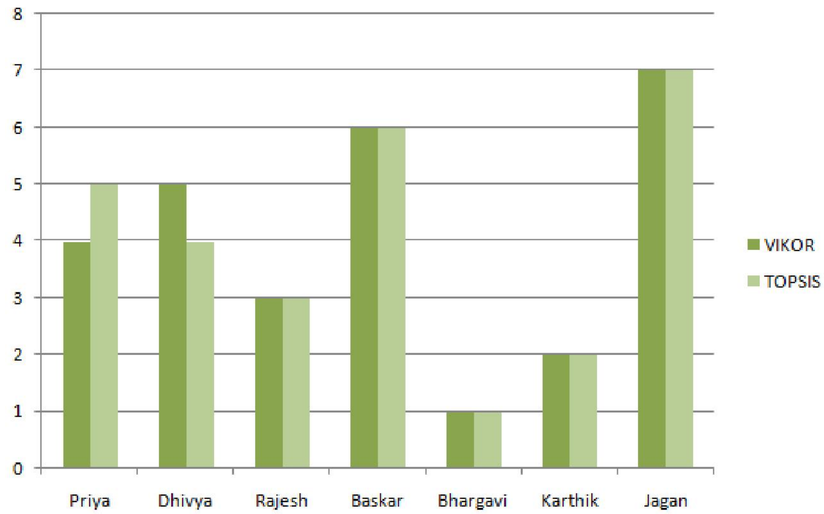

Fig:5 Graphical representation which shows the comparison of VIKOR and TOPSIS method

IV. RESULT AND DISCUSSION

Table 3 shows the combination of ratings for the alternatives, which were obtained from the decision-makers. The ratings were then used to construct the normalized decision matrix, as shown in Table 4.The ranking values of the VIKOR method are presented in Table 5, which shows that Alternative A1 has the highest ranking value, followed by Alternative A2 and Alternative A3. The graphical representation of the VIKOR method is shown in Figure 3.The ranking values of the fuzzy TOPSIS method are presented in Table 6, which shows that Alternative A1 has the highest ranking value, followed by Alternative A2 and Alternative A3. The graphical representation of the TOPSIS method is shown in Figure 4.A comparison of the fuzzy VIKOR and fuzzy TOPSIS methods is presented in Table 7, which shows that both methods yield similar ranking results. The graphical representation of the comparison is shown in Figure 5.

V. CONCLUSION

This study establishes a ranking model that utilises the selection of qualified person in a academic institution including textual information and numerical information to rank academician.The proposed model integrates VIKOR and TOPSIS, in order to solve MCGDM problem.We use Entropy method to deal with textual information and obtain criteriaweights.We conclude that ranking for the alternatives of qualified persons using VIKOR and TOPSIS model have the same preference solution. We can use such a procedureto other future applications for qualities of medicines ,clothes,and so on.

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