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Selection of Fighter Aircraft by using Multi-Attribute Decision Making Methods

Onkar Sawant *, **Kunal Rajurkar, Sanket Khade, Mangesh Dobe, and Avinash Kamble**

Department of Mechanical and Civil Engineering, MIT Academy of Engineering, Alandi, Pune

**Corresponding author:* Sawant O, Department of Mechanical and Civil Engineering, MIT Academy of Engineering, Alandi, Pune, Email: osawant@mitaoe.ac.*

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Abstract

Fighter aircraft is the basic operational means of air force. A decision making process requires the value of conflicting objectives for alternatives and the selection of the best alternative according to the needs of decision makers. Analytical Hierarchy Method, Multi- Objective optimization by ratio analysis Method and Viekriterijumsko Kompromisno Rangiranje methods provide Solution for this selection. Fighter Aircraft is the important base for an Air Force and it plays a crucial role in air-force. So, Every Country`s military wants best aircrafts to complete the operations successfully. It is the most important thing to select Advanced and well equipped Fighter Aircraft to increase the strength of Air Force and also it is the big task for Defense Ministry of any country to select Fighter Aircraft with such qualities within budget allotted to Air Force. In choosing the right Fighter Aircraft, there is not always a single definite attribute for selection. Selectors have to take into account a number of attributes. Quality of aircraft changes with the change in Different attribute for selecting the best Possible Fighter Aircraft. This paper helps to find the best alternative as a multi-criteria decision making problem. This paper presents way to select best possible fighter aircraft by using Analytical hierarchy process, Multi-Objective Optimization by Ratio Analysis Viekriterijumsko Kompromisno Rangiranje on the basis of different attributes.

Keywords: Fighter Aircraft Selection, MOORA, AHP, VIKOR

Introduction

Indian Air Force stands at number four in the list of strongest Air Force in the world following US, Russia and Israel at top three positions. With about 1.7 lakhs of personals and about 1500 aircraft, Indian Air Force stands ahead of the Royal Air Force of the United Kingdom, China, France and other nations. So, complex information management is an important part in selection for machines in air force to increase strength of air force. Fighter Aircraft is one of the important parts in Air Force. So, it has to choose on multiple criteria. In selection of fighter aircraft Problems involves multiple data sets, some precise or objective and some uncertain or subjective. Many researchers have applied Multi-Attribute Decision Making (MADM) method to predict the selection of Fighter Aircraft. Sakir and Laskar [1] have worked on design and optimization of a multi-role fighter aircraft. Multi-role fighter aircraft is one of the latest innovations of science and technology. A multi-role fighter aircraft carrying one pilot that covers a range of 2000 NM with a maximum Mach number of 2 has a maximum ceiling of 65000 ft. is designed in that paper. J. Wang et al [2] have done work on air combat effectiveness assessment of military aircraft using a fuzzy Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methodology. A wide range of statistical and non-statistical decision making techniques have been proposed in such type of problem to model complex Engineering problem. MADM methods are among the techniques that have recently been gaining extraordinary popularity and wide application. Due to lack of data in problems statistical method are useful in selection problem with incomplete data. Meanwhile, non-statistical methods are useful for selection problems with imprecise, ambiguous or vague data. The next rather frequent application of MADM Techniques is for the assessment of service quality in different industries and various types of economic activities. Fighter aircraft, often referred to simply as a fighter, is a military fixed-wing aircraft designed primarily for air-to-air combat against other aircraft. The key performance features of a fighter include not only its firepower but also its high strength, speed and maneuverability relative to the target aircraft. MCDM methods often create different outcomes to select or rank a set of decision alternatives. Voogd showed that, at least 40% of time, each technique produces Different results from any other technique. Thus, the concept of compromise solution is critical in MCDM to overcome the above drawbacks, a comprehensive algorithm for all kinds of criteria, including positive, negative and target values, with emphasizes on compromise solution, is presented in this paper.

Literature Survey

Many researchers and industries are working on MCDM techniques as well many of researches have done on these techniques by using various problem statements. Here are the some of them researches in short as a literature survey. Grimaldi and Rippa [3] applied AHP framework to select the most relevant set of knowledge management tools to assist the innovation processes in an organization. It helps to identify the key knowledge management to authorize the innovation. It improves the stability in global market and considered as potential factor for the organization. Effective use of knowledge increases the level of innovation and hence it is predominant. This framework implemented the proper judgment to appraise the suitable tools to enhance the innovation in an organization. Rajput et al. [4] applied AHP method to choosing a car. This paper aimed to select a best suitable car on the basis of various attribute as the family might decide to consider style, comfort, fuel economy, and cost as the criteria for making their decision. They subdivided the cost criterion into purchase price, fuel costs, maintenance costs, and resale value. The

AHP provides a structure on decision-making processes where there are a limited numbers of choices but each has a number of attributes applied MADM methods for determination of best military cargo aircraft. The aim of this study is to determine the best options, by using multi-criteria decision-making approaches, for supplying military cargo aircraft, such as the AHP, Simple Additive Waiting (SAW), Elimination Et Choix Traduisant la REalité (ELECTRE) and TOPSIS methods. In this study, the military cargo aircraft are examined in order to determine if they meet the needs of and make a contribution to the Air Force in a deterrent capacity has used the AHP methodology to analyze the Coastal Tourism Sites, Selected the Post Dickson District as study area in Negeri Sembilan state in Malaysia the study done by the AHP by integrating the Geographic Information System (GIS). It helps for the sustainable development of selected area and reduces economical as well as social pressure to attain the harmony. In this area, geographical barriers are there as specify in the paper so, it's difficult to decide coastal tourism sites by only local priority. For that GIS based AHP Approach has been done to recommend the best choice of tourism site. applied concept of Multi-objective Optimization on the basis of ratio analysis (MOORA) method has been applied for solving multiple-criteria (objective) optimization problem in welding. The decision maker applied six decision-making problems which include selection of suitable welding parameters in different welding processes such as submerged arc welding, gas tungsten arc welding, gas metal arc welding, CO2 laser welding, and friction stir welding are considered in this paper. Datta et al. [8] have applied concept of MOORA method to report an efficient decision-support system for industrial robot selection. It seeks to analyze potential robot selection attributes with a relatively new MCDM approach which employs grey set theory coupled with MULTIMOORA method. Brauers and Zavadskas have applied MOORA method for privatization in a transition economy i.e. if application is situated originally in a "welfare" economy, centered on production, MOORA becomes even more significant in a "wellbeing economy", where consumer sovereignty is assumed. applied MOORA method for Multi-Objective contractor's ranking. The MOORA method based on ratio analysis and dimensionless measurement will accomplish the job of ranking the contractors in a non-subjective way. The decision maker applied this method as an application the largest maintenance contractors of dwellings in Vilnius, capital of Lithuania, were approached applied Viekriterijumsko Kompromisno Rangiranje (VIKOR) method for mathematical modeling. The aim of this paper is to extend the VIKOR method for decision making problems with interval number. The extended VIKOR method's ranking is obtained through comparison of interval numbers and for doing the comparisons between intervals, we introduce as optimism level of decision maker. applied VIKOR for Multi- criteria Personnel Selection. In this the triangular fuzzy numbers are used to evaluate the suitability of personnel and the approximate reasoning of linguistic values. For evaluation, they have selected five information culture criteria. The weights of the criteria were calculated using worst-case method. After that, modified fuzzy VIKOR is proposed to rank the alternatives. A comparative analysis of results by fuzzy VIKOR and modified fuzzy VIKOR methods is presented. Experiments showed that the proposed modified fuzzy VIKOR method has some advantages over fuzzy VIKOR method. Firstly, from a computational complexity point of view, the presented model is effective. Secondly, compared to fuzzy VIKOR method, it has high acceptable advantage compared to fuzzy VIKOR method [5]. Applied fuzzy VIKOR (IF-VIKOR) method is based on a new distance measure considering the waver of intuitionistic fuzzy information. The method aggregates all individual decision-makers' assessment information based on intuitionistic fuzzy weighted averaging operator (IFWA), determines the weights of decision-makers and attributes objectively using intuitionistic fuzzy entropy, calculates the group utility and individual regret by the new distance measure, and then reaches a compromise solution. It can be effectively applied to multi-attribute decision-making (MADM) problems where the weights of decision-makers and attributes are completely unknown and the attribute values are intuitionistic fuzzy numbers (IFNs) have applied An Extended VIKOR Method for Multiple Attribute Decision Analysis with Bi- dimensional Dual Hesitant Fuzzy Information. In order to address complex multiple attribute decision analysis (MADA) problems, an extension of fuzzy VIKOR method in BDHF context is proposed in this paper. In VIKOR method for MADA problems, weight of each attribute indicates its relative importance. To obtain weights of attributes objectively, a new entropy measure with BDHF information is developed to create weight of each attribute. Finally, an evaluation problem of performance of people's livelihood project in several regions is analyzed by the proposed VIKOR method to demonstrate its applicability and validity. From above literature review, it has been observed that many of the researchers have worked on AHP, MOORA and VIKOR method for different application including fighter aircraft application. But, very few researchers have worked on the same application by using different methods as done in this paper. In this paper, different types of MADM methods such as (AHP), (MOORA) and (VIKOR) have applied for selection of fighter aircraft to select best alternative on the basis of different attributes.

MADM Methods

AHP method

AHP method is developed by Thomas L. Saaty in the 1970s that partnered with Ernest Forman to develop expert choice in 1983, and has been extensively studied and refined since them. AHP is a MADM technique to prioritize the complex and unstructured data to obtain the most preferred Alternative based on mathematical approach. Efficient and Effective methodology in the field of decision making to attain the best result. It includes the specialized form of solution and establishes the relations within the hierarchical structure using pairwise comparison. Each Element subjected to judgmental approach individually in decision process. It is multi-attribute decision-making approach being implemented to find the finest outranking of Alternatives.Steps in AHP process are presented as follows:

Step 1: Develop the hierarchical structure includes objective [Goal], Attributes [Criteria] and Alternatives.

Step 2: Determine the relative importance of different Attributes with respect to goal. (Calculation of weights)

Prepare the pair wise comparison decision matrix using the relative importance or intensity of importance scale given by table 1. It uses to analyze the performance rating between the attributes. The length of decision matrix depends on the number of attributes and contains equivalent number of rows and column. Comparison of attributes with respect to itself appoints value of 1. So, the diagonal of pair wise matrix is being filled with value 1. Consider attributes A with row m and column n computes the square matrix BA*A and Cmn defines the comparison of attribute m with attribute n. In decision matrix if bmn = 1 then Bnm = 1 / bmn Calculate relative normalized weight of

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attributes individually by taking geometric mean of ith row using geometric mean method.

GMn = [∏ bmn]1/M [formula for geometric mean calculations (GMn)]

Wn = GM / ∑ GMn [formula for weight calculations (Wn)]

Intensity of importance	Verbal Scale	Description
1	Equal importance	Two activities contribute equally to the objective.
3	Weak importance of one over another	Experience and judgment slightly favour one activity over Another.
5	Essential or strong importance	Experience and judgment strongly favour one activity over another.
7	Demonstrated importance	An activity is strongly favoured and its dominance Demonstrated in practice.
9	Absolute importance	The evidence favouring one activity over another is of the Highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed.

Table1: Intensity of importance.

Step 3: Derive or check the consistency (weights correct or not) Assume A1 = pairwise comparison matrix

A2 = [weights of attributes]

A3 & A4 can be compute as A3 = A1 * A2 and A4 = A3 / A2 Eigen value (Λmax) i.e. average of matrix A4 [Λmax = A4 / M]

Calculate the consistency index (CI) by Consistency Index = (Λmax – M) / (M – 1) Consistency Ratio = CI / RI

Where, RI is the Random Index taken from the table 2 with Respect to the number of attributes.

Attribute	3	4	5	6	7	8	9	10
RI	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49

Table2: Random index on the basis of number of attributes.

Calculated consistency ratio must be less or equal to o.1 then only it acceptable if not then change the decision matrix and repeats from step 2.

Step 4: Calculate the normalized weight of each attribute by the local priority.

Step 5: Calculate the overall performance rating of priorities and final decision. Determine the overall performance rating for the alternatives by multiplying the relative normalized weight (wn) of each attribute (obtained in Step 2) with its corresponding normalized weight value for each alternative (obtained in Step 4) and employs summation over all the attributes for each alternative.

Multi-objective optimization by ratio analysis

Multi-Objective Optimization On The Basis Of Ratio Analysis is widely used because of its computational time is fast as well as very minimal number of mathematical calculation used in this method. This method is introduced by brauers in 2004 as an objective method. MOORA is a compensatory method (Desirable and undesirable criteria are used simultaneously for Ranking). The method especially employed for Quantitative attributes only. It is the process of simultaneously optimizing two or more conflicting attributes (goals) subject to certain restrictions. The MOORA method, first introduced is a Multi-objective optimization technique that can be successfully applied to solve various types of complex decision-making problems in a manufacturing environment.The MOORA Method is measurably consisting of two components as follows.

Ratio System (2004)

Reference Point Approach (2006)

Steps in MOORA Method are as follows, Step 1: Create a Decision Matrix

The first step is based on selection problem, the alternatives and attributes values in the decision matrix are considered as X.

$$X = \begin{pmatrix} X_{11}\, X_{12} \ldots \ldots X_{1n} \\ X_{21}\, X_{22} \ldots \ldots X_{2n} \\ \ldots \quad \ldots \quad \ldots \ldots \ldots \\ \ldots \quad \ldots \quad \ldots \ldots \ldots \\ X_{m1}\, X_{m2} \ldots \ldots X_{mn} \end{pmatrix}$$

The Normalized decision matrix is represented as the Xij matrix, where ‘i’ is, m that is the number of alternatives whereas j represents n in the number of criteria, equation (1) is the matrix representation of the decision. The matrix needs to be normalized by using the

□□□ □ = □□□/√[∑ □□□^2 =1] (j = 1, 2, ...(1)

Estimation of assessment values Here, the normalized data need to multiply with weight criteria for all the alternatives. Formulti-objective optimization, these normalized performances are added in case of beneficial attributes and subtracted in the case of non-beneficial attributes, given in expression. Here, the weight criteria can be estimated by using the AHP process or entropy process

□□ = $\sum_{j=1}^{g}$ □□□□□□ − $\sum_{j=g+1}^{n}$ □□□□□□ (j= 1, 2, …, □) ....(2)

The value of yi can be positive or negative depending on its maximal number (favorable attribute) and minimal (unfavorable attribute) in the decision matrix. The ordinal rank of yi shows the final preference. Thus, the best alternative has the highest yi value, while the worst alternative has the lowest Yi value.

Viekriterijumsko kompromisno rangiranje

The VIKOR method was developed for Multi-criteria optimization of complex systems. It determines the compromise ranking-list, the compromise solution, and the weight stability intervals for preference

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stability of the compromise solution obtained with the initial (given) weights. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. It introduces the multi-criteria ranking index based on the particular measure of ‘‘closeness’’ to the ‘‘ideal’’ solution (Opricovic, 1998). Assuming that each alternative is evaluated according to each criterion function, the compromise ranking could be performed by comparing the measure of closeness to the ideal alternative. The compromise solution for a problem with conflict criteria can allow the decision makers to reach a final decision. The compromise solution is a feasible solution that is closest to the ideal solution, and compromise means an agreement established by mutual concession. The multiple attribute merit for compromise ranking was developed from the Lp-metric used in compromise programming method. The VIKOR method was developed as a multi-criteria decision making method to solve discrete decision problems with non-commensurable and conflicting criteria. This method focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria, is to help decision makers reach the final destination. The main procedure of the VIKOR method is described below,

Step 1: To determine objective, and to calculate best and worst values of all attributes. We need to find out the Best values having maximum value of Beneficial and minimum value of non-beneficial. Similarly, minimum value of beneficial and maximum value of non-beneficial in Worst values.

Step 2: Calculate the optimal and inferior solution of schemes comprehensive evaluation. In this Step there is a need a Weight, which is already find by AHP Method. Then, optimal solution and inferior solution can be easily calculated by following equations (3) and (4).

$$E_i = {}_j \left(\left((m_{ij})_{max} - (m_{ij})\right) / \left((m_{ij})_{max} - (m_{ij})_{min}\right)\right) \quad \ldots\ldots(3)$$

$$F_i = \text{Max of }_j\left(\left((m_{ij})_{max} - (m_{ij})\right) / \left((m_{ij})_{max} - (m_{ij})_{min}\right)\right) \quad \ldots\ldots(4)$$

Step 3: Calculate the value of interests ratio brought by scheme. For value of interest ratio, find Emin, Eimax, Fmin and Fmax all this values which are already find out in Step 2 will be putted in the following equation (5).

$$P = \left(v\,(E - E_{min}) / (E_{max} - E_{min})\right) + \left((1-v) * (F - F_{min}) / (F_{max} - F_{min})\right) \quad \ldots\ldots(5)$$

Step 4: Arrange the alternatives in the ascending order according to values of interest ratio. After the alternatives are arranged according to ranks, the first alternative is the best solution and is closest to the ideal solution and the last alternative is the worst solution and is closest to negative ideal solution.

Problem Statement for selection of Fighter Aircraft

Fighter aircraft is the base for air force. So, it has to keep in mind that best aircraft needed for air force. If wrong aircraft is selected then it increases the high risk of damage to the force and a country during the war. Therefore, the selection of appropriate fighter aircraft is very important aspect to improve the efficiency of air force. In this problem statement of fighter aircraft the authors have taken the four alternatives as fighter aircraft (A, B, C and D) with four attributes (Maximum speed, Fairy range, Maximum period and Acquisition cost) in this acquisition cost is the non-beneficial criteria and the remaining are the beneficial criteria. Following table 3. shows the different alternatives and the various criteria/ attributes.

Alternatives	Beneficial Criteria		Cost Criteria	
	Maximum Speed	Fairy Range	Maximum Periods	Acquisition Cost
A	2	1500	20000	5.5
B	2.5	2700	18000	6.5
C	1.8	2000	21000	4.5
D	2.2	1800	20000	5

Table3: Criteria for fighter aircraft.

Solutions Using MADM techniques

Ahp method

Step 1: The objective is to select the correct fighter Aircraft for the Air Force among the available aircraft.

Step 2: Determine the relative importance of different Attributes with respect to goal (calculation of weights). Table 4 shows the pairwise comparison decision matrix using relative importance.

Attributes	Beneficial criteria		Cost criteria	
	Maximum speed	Fairy range	Maximum Payload	Acquisition cost
Maximum speed	1	7	5	3
Firing range	44378	1	44228	44256
Maximum Payload	44317	2	1	44256
Acquisition cost	44256	3	3	1

Table4: Pairwise comparison decision matrix.

Calculate the geometric mean of each ith row.

GM1=(1*7*5*3)1/4=3.2010; GM2=(1/7*1*1/2*1/3)1/4=0.3928; GM3=(1/5*2*1*1/3)1/= 0.6042; GM4=(1/3*3*3*1)1/4= 1.3160 Sum of geometric mean = 5.514

Weight of attributes can be calculated by geometric mean of each row divided by sum of geometric mean. Hence,

W1 = 0.5805, W2 = 0.0712, W3 = 0.1095, W4 = 0.2386

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$$A_1 = \begin{pmatrix} 1 & 7 & 5 & 3 \\ 1/7 & 1 & 1/2 & 1/3 \\ 1/5 & 2 & 1 & 1/3 \\ 1/3 & 3 & 3 & 1 \end{pmatrix} \quad A_2 = \begin{pmatrix} 0.5805 \\ 0.0712 \\ 0.1095 \\ 0.2386 \end{pmatrix}$$

$$A_3 = A_1 * A_2 = \begin{pmatrix} 2.3422 \\ 0.2884 \\ 0.4475 \\ 0.9742 \end{pmatrix} \quad A_4 = A_3/A_2 = \begin{pmatrix} 4.0_{s}347 \\ 4.5050 \\ 4.0867 \\ 4.0829 \end{pmatrix}$$

Now, the maximum Eigen value is calculated by taking the average of matrix A4

i.e. Λmax = A4 / 4 = 4.0637. Consistency Index (CI) = Λmax – M / M – 1 = 4.0637 – 4 / 4 – 1 = 0.0212 Consistency Ratio (CR) = CI / RI = 0.0212 / 0.89 = 0.0238 [Value of RI is taken from the table for the 4 attributes] As the CR > 0.1 hence Weights are correct.

Step 4: Calculate the normalized weight for each alternative [table 5].

Alternatives	Beneficial Attributes			Cost Criteria
	Maximum speed	Fairy range	Maximum Payload	Acquisition cost
A	0.8	0.55	0.95	1.2
B	1	1	0.85	1.4
C	0.72	0.74	1	1
D	0.88	0.66	0.95	1.1

Table5: Normalized Matrix.

Step 5: Calculate the overall performance score of priorities and final decision.

Determine overall performance rating for the alternatives by multiplying the relative normalized weight of each aircraft attribute with respect to its normalized weight value of each aircraft. Alternatives and employs summation to overall attributes for each alternative mentioned in table 6.

Attributes	Beneficial Attributes			Cost Criteria
Normalized Weight	Maximum speed	Fairy range	Maximum Payload	Acquisition cost
	0.5805	0.0712	0.1095	0.2386
A	0.8	0.55	0.95	1.2
B	1	1	0.85	1.4
C	0.72	0.74	1	1
D	0.88	0.66	0.95	1.1

Table6: Normalized weighted matrix.

Overall performance rating

A = (0.8*0.5805)+(0.55*0.0712)+(0.95*0.1095)+(1.2*0.2386) = 0.8939; B=(1*0.5805)+(0.1*0.0712)+(0.85*0.1095)+(1.4*0.2386)=1.0788;C=(0.72*0.5805)+(0.74*0.0712)+(0.1*0.1095)+(1*0.2386)=0.8187;D=(0.88*0.5805)+(0.66*0.0712)+(0.95*0.1095)+ (1.1*0.2386) = 0.9243

Next step is to arranged the alternatives according to the performance rating In descending order as the higher value is essential.So, the outranking will be [B], [D], [A], [C] Hence, B will be the outcome as final decision.

MOORA Method

Create Decision Matrix

The Alternatives and Attributes are copied in the spreadsheet and weights have to be taken from the AHP process. The authors have to highlight maximum value of benefit criteria and minimum value of non-beneficial criteria i.e. cost criteria from the given decision matrix in the table 7.

Alternatives	Benefit Criteria		Cost Criteria	
	Maximum Speed	Fairy Range	Maximum Periods	Acquisition Cost
A	2	1500	20000	5.5
B	2.5	2700	18000	6.5
C	1.8	2000	21000	4.5
D	2.2	1800	20000	5
Weights	0.5805	0.0712	0.1095	0.2386

Table7: Decision matrix.

Normalize Decision Matrix For this formula has been given below,

□□□ ∗ = □□□/ √ [∑ □□□^2 □ □=1] (j = 1, 2, …, □)

To calculate the value of Xij firstly, we just have to square the value of X as shown in the table 8.

X^2				
A	4	2250000	4E+08	30.25
B	6.25	7290000	3.24E+08	42.25
C	3.24	4000000	4.41E+08	20.25
D	4.84	3240000	4E+08	25

Table8: To calculate the value of Xij firstly, we just have to square the value of X

Now, do the summation with respected to column and simultaneously take the square root of that summation using following formula.

√[∑X□□^2□ □=1]	4.281354926	4096.33983	39560.08089	10.85126721

Now, Authors able to calculate the value of Xij* as given in the table 9. by using the above formula given in the second step.

Xij*				
A	0.4671	0.3661	0.5055	0.5068
B	0.5839	0.6591	0.455	0.599
C	0.4204	0.4882	0.5308	0.4146
D	0.5138	0.4394	0.5055	0.4607

Table9: Normalized Decision Matrix.

Step 3: Estimation of Assessment Values

$$yi = \sum_{j=1}^{g} wjxij* - \sum_{j=g+1}^{n} wjxij* \; (j = 1, 2, \ldots, n)$$

For calculating the value of Yi Firstly, it has to multiply the weight criteria i.e. Wj into the value of Xij* to get WjXij* as given in the table 10.

WjXij*				
A	0.2711	0.026	0.0553	0.1209
B	0.3389	0.0469	0.0498	0.1429
C	0.244	0.0347	0.0581	0.0989
D	0.2982	0.0312	0.0553	0.1099

Table10: Multiplication of Normalized matrix and weight matrix.

Now, Authors can easily calculate the value of Yi by subtracting the value from beneficial Criteria to non-beneficial criteria as shown in the table 11.

Alternatives	**Yi**
A	0.2316
B	0.2927
C	0.238
D	0.2749

Table11: Rank of alternatives.

Arrange the value of Yi in an Ascending order to get the rank. After arranging the value according to the rank, the first alternative is the best solution and is closest to the Positive ideal solution and the last alternative is the worst solution and is closest to negative ideal solution. Hence, from above table we have gotten the rank B-D-C-A.

From above, we conclude that the B Fighter Aircraft is the first choice and it is most suitable Fighter Aircraft after that Fighter Aircraft D and C are the second and third choice for selection and the worst choice is the A Fighter Aircraft. Further, exact values of attributes are used in this paper for comparing the alternative fighter aircraft criteria in satisfying each of the four attributes. Thus, the method provides a more realistic fighter aircraft selection procedure present.

VIKOR Method

Step 1: To determine objective, and to calculate best and worst values of all attributes. So, we easily find out the Best values and Worst values by finding maximum and minimum values of maximum speed, Firing Range, maximum periods, Acquisition Cost as shown in table no. 12

Criteria	**Best value**	**Worst value**
	(Maximum value)	**(Minimum value)**
Maximum Speed	2.5	1.8
Fairy Range	2700	1500
Maximum Periods	21000	18000
Acquisition Cost	6.5	4.5

Table12: Best and worst values.

Calculate the optimal and inferior solution of schemes comprehensive evaluation. In this step we need a Weight, which is already found by AHP Method. Then, optimal solution as shown in table no. 13 and inferior solution as shown in table no. 15 can be easily calculated by following equations (6) and (7).

Ei =j (((mij) max– (mij)) / ((mij) max– (mij) min)) ……(6)

Fi=Max of j(((mij)max– (mij)) / ((mij)max – (mij)min)) ……(7)

E1	0.6416
E2	0.3481
E3	0.8606
E4	0.48105

Table13: Optimal solution.

Calculate the value of interests ratio brought by scheme. For value of interest ratio, we find Emin, Eimax, Fmin and Fmax all this values which we already find out in Step 2 as shown in table no 14 and table no 16 will be putted in the following equation (8).

P= (v (E-Emin) / (Emax-Emin)) + ((1-v)*(F-Fmin) / (Fmax-Fmin)) ……(8)

P1	0.5436
P2	0
P3	1
P4	0.144

Table17: Value of interest ratio.

Step 4: Arrange the alternatives in the ascending order according to values of interest ratio. After the alternatives are arranged according to ranks, the first alternative is the best solution and is closest to the ideal solution and the last alternative is the worst solution and is closest to negative ideal solution.

Hence, the best Rank is B-D-A-C From the above values of criteria of Fighter aircraft, it is clear that the fighter aircraft designated as (2) is the best choice for aircraft selection for the given conditions. The second choice is (4), third choice is (1), and the last choice is (4). Therefore, the order of criteria of fighter aircraft is B-D-A-C. Further, exact values of attributes are used in this paper for comparing the alternative fighter aircraft criteria in satisfying each of the four attributes. Thus, the method provides a more realistic fighter aircraft selection procedure present.

Results and Discussion

In this study, a number of techniques have been studied as individual techniques and they are integrated or combined with other techniques. As a result, this review article can provide a better understanding of MCDM techniques and approaches for future academic scholars. Selection of fighter aircraft for the air force has been resolved by Analytical Hierarchy Process, Multi- objective Optimization by Ratio Analysis & VIKOR. And from result it has been observed that the 'B' is the best alternative followed by 'D' at the second position. Following table 18 shows the ranks of fighter aircraft for each alternative by different methods. Fig. 1 shows comparison of the ranks of different alternatives evaluated by different MADM methods.

Alternatives	AHP	MOORA	VIKOR
A	3	3	3
B	1	1	1
C	4	2	4
D	2	4	2

Table18: shows the ranks of fighter aircraft for each alternative by different methods.

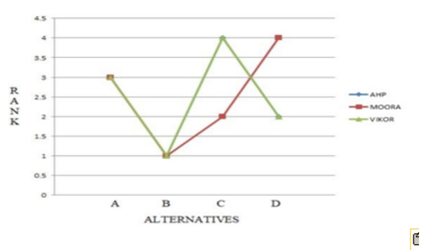

Figure1: Raking of MADM methods.

Hence, it shows the best alternative depending on the various attribute. Accordingly, study notifies the significance of multi attribute decision making and improve the selection of correct alternative.

Conclusion

The popularity of MADM Techniques in day to day application has increased significantly in recent times. The present methodology based on Analytical Hierarchy Process, Multi-Objective Optimization by Ratio Analysis & Viekriterijumsko Kompromisno Rangiranje is the Multi- Attribute Decision Techniques which helps to nominate the correct Aircraft alternative for the Air force. It recommends the best specification of Aircraft which will be more effective for the Air force and enhance the selection procedure and from the above techniques we conclude that 'B' is the best Fighter Aircraft among these four alternatives. This analysis has been done based on the four attributes. This study will be employed by academics and Air Force as a basis for further research and will help practitioners make more appropriate decisions using these techniques, and guide scholars as well those who working on this problem and techniques to enhance these methodologies.

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