

Measuring The Performance of Banks Using Combination of AHP-Vikor Analysis

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Abstract

Introduction: In India, the banking sector is materialised as one of the strongest drivers for up gradation of the economic sector. The financial sector plays a chief role in the effective utilisation of resources. In last decades banking sector are showing relatively quantum leap. Like other sectors it essential for the bank to transform its input in such a way to get maximum output at efficient operation. Leading banking system creating a more competitive environment for each and every county to built advance structure in the banking sector. Measurement of banks efficiency helps to know its strength and shortfall. In competitive world performance measurement is becoming a chief way to lead success. Various literature previews to improve the efficiency level of banks and trying to measure and benchmark the preference level continuously. In present paper combination of AHP and Vikor method is used to rank 26 Indian Public Sector banks for period 2015-16 based on various inputs and outputs criteria. Both techniques AHP and Vikor are multicriteria decision making tools are used where a number of alternatives decision is evaluated. AHP is used to evaluate the weight of various inputs and outputs criteria. A Vikor method is used to rank the different banks and for reliability and validity, the application of Sensitivity analysis is employed. The previous study likes Thiagarasu and Rengaraj, (2017), Rao, Sai&Babu (2017), Thipparat and Chaisongkroh (2016), Wang and Chen (2014), Fallahpour and Moghassem (2014), Thipparat and Thaseepetch (2013), Sayadi (2009), Opricovic and Tzeng (2004), (Triantaphyllou and Mann (1995) studied to measure the performance of various sector using Vikor, DEA and Topsis method in different area like supplier selection, robot spinning, chemical product, interval number, e- business and many more but least work is employed in area of public sector banks so Researchers in the present study attempt to measure the performance of the Indian Public Sector banks using combination of AHP and Vikor methods.

Purpose: In modern epoch measuring the performance of the bank is a major facet of the financial sector for its diversification. Estimating the performance of an organisation is one of the multicriteria decision making problem (MCDM). It offers optimal solution and alternatives to take a most appropriate decision. Present paper aspires to evaluate the performance and rank the Indian public sector banks using a combination of the AHP and the VIKOR method for the year 2015-16.

Design Methodology: Firstly the research objective is developed, and then the data were collected and evaluated by combining two multi-criteria decision-making (MCDM) tools like AHP and VIKOR method. MCDM is a /7branch of operation research deals with complex decision making problem. It is also well known as Multi criteria decision analysis. The quality of results will depend on AHP, VIKOR and Sensitivity test which is relevant to the research objective. In resnet paper various inputs and outputs variables are considered. Inputs factor like Total Assets (X1), Deposits (X2), Operating Expenses (X3) and outputs factor like Operating Profit (Y1), Investment (Y2) and loan and advances (Y3) were involved. In this paper, 26 Indian Public sector banks are considered as DMUs. The present study is mainly based on secondary data which were collected from various banks annual reports and the Reserve Bank of India's Profile of Banks. And primary data are collected for AHP techniques which are collected from bank managers. For this, bank managers were asked regarding the level of the consequence of each aspect with respect to each other. The response of bank managers on each of the criterion is taken into consideration is in the Likert-type 1-9 scale.

Findings: The weighted result of AHP analysis is calculated for both inputs and outputs criteria. Result of AHP weight for inputs X1, X2, X3 and outputs Y1, Y2, Y3 are (0.546, 0.384, 0.069, 0.264, 0.656, and 0.079). There may be issues like inconsistency in few cases, however no such problems are encountered in the current study. To see the consistency level consistency ratio are acquired and compared to the random index. If consistency ratio is less than 0.10 than only analysis can continue further. Hence in current study consistency ratio for both inputs and outputs are 0.093 and 0.019. AHP weighted scores (W_{AHP}) so acquire are further utilised by a Vikor method for the period 2015-2016 to ranks the performance of public sector banks in India. Vikor analysis help to select the best alternative and rank them, it helps to solve the complex problem which leads to a final decision (Opricovic and Tzeng, 2007). In current study decision matrix is taken as bank original data which were normalised, the weighted normalised matrix is constructed thereafter, to get weighted normalised data weight (W_j) is multiplied with normalised matrix (R_{ij}). The relative importance weight factors for all inputs and outputs criteria are calculated with the help of AHP. In a Vikor method for all criterion function best (f_j^+) and worst (f_j^-) value are determined which are the positive and negative ideal solution of j th criteria. The Maximum criterion function (f_j^+) is the highest value in the column of the Normalised matrix. For year 2015-16 the Maximum criterion function (f_j^+) for inputs X1, X2, X3 and outputs Y1, Y2, Y3 are (0.86039, 0.78614, 0.86280, 0.88528, 0.69692, 0.75180). Likewise, Minimum criterion function (f_j^-) is the smallest value in the column of the Normalised matrix. For year 2015-16, the Minimum criterion function (f_j^-) for inputs X1, X2, X3 and outputs Y1, Y2, Y3 are (0.01599, 0.00486, 0.02859, 0.01893, 0.02939, 0.02771) and then the value of Utility measure (S_i) and Regret measure (R_i) is determined Utility measure is the sum of each row criteria of best value and regret measure is the maximum value of each row (a distance of best value).

The result of Utility measure (Si) and Regret measure (Ri) shows that State Bank of India is considered as a most efficient bank with minimum utility and regret value (0.000). After getting the value of utility and regret measure next to find the Vikor Index for determining the optimal solution. The alternative DMUs can be ranked using Vikor index. The smaller value determines with the Vikor Index is taken as one of the best among other alternatives. Combination of AHP and Vikor analysis method result exemplify that State Bank of India (DMU 14) is the most leading alternatives having the lowest Vikor Index 0.00000, next to it are Punjab National Bank (0.736618) and Canara Bank (0.760598). So, State Bank of India is chosen as top performing bank among 26 alternatives and ranked as 1, as well becomes the benchmark for other DMUs. To make the result evaluation more sensitive and accurate the sensitivity analysis is executed for the weighting vectors in order to know how much deviation is taken place in each case when weight value is changed. When we change the AHP weight value of various variables the result of sensitivity analysis shows the same result as that of VIKOR analysis, State Bank of India (DMU 14) is the most dominant alternatives having the lowest Vikor Index 0.0000, next to it are Punjab National Bank (0.737188), and Canara Bank (0.760621) with 2nd and 3rd position.. Finally, study interprets that result obtained were consistent and stable. Present work provides a scope for further studies and also provides a guideline for the banks to measure performance.

Conclusion: In cut-throat competition computing the performance and taking an appropriate decision is the key feature for the expansion and intensification. The proposed work used AHP and Vikor method to measure the performance of Indian public sector bank and rank them according to their performance. Sensitivity analysis is used in a Vikor method. The procedure for AHP and Vikor method is discussed in detail. The study involves an epitome structure with help of AHP-VIKOR analysis. AHP is used to determine a diverse weight for each input and output criteria. The evaluation of input and output weight result shows that Total assets and Investment are found to be highest input and output weight Variables likewise Operating expenses and loan and advances are found to be least weight Variables and this weight are further utilized while figuring out the rank with help of VIKOR method.

VIKOR result indicate State Bank of India is found to be a most competent bank with minimum VIKOR Index (0.000) for year 2015-16 next to it are Punjab National Bank (0.736618), and Canara Bank (0.760598). To make the result evaluation more sensitive and accurate the sensitivity analysis is carried out for the weighting vectors. when we change the AHP weight value State Bank of India (DMU 14) is the most dominant alternatives having the lowest Vikor Index, next to it are Punjab National Bank and Canara Bank. The result of sensitivity analysis shows the same result as that of VIKOR analysis.

Research extent a scope for future research, the method used in the present study can be Compare with other MCDM methods and also taking into consideration other input and output criteria. Further research can be extended for the additional time period.

Keywords: Banking, efficiency, analytics hierarchy process, vikor, performance ranking, sensitive analysis.

1. Introduction

In India banking sector is materialised as one of the strongest driver for up gradation of economic sector. The financial sector plays a chief role in effective utilisation of resources. In last decades banking sector are showing relatively quantum leap. Like other sector it essential for bank to transform its input in such a way to get maximum output at efficient utilisation. Leading banking system creating more competitive environment for each and every county to built advance structure in banking sector. Measurement of banks efficiency helps to know its strength and short-falls. In competitive world performance measurement is becoming a chief way to lead success.

In competitive environment measuring the performance is crucial to understand the position of firm against its competitor and benchmark firm (Sakinc and Acikalin, 2015) ^[1]. Hence, in banking sector wide range methods are used to evaluate the performance, Vikor analysis is one of them.

Vikor analysis is one of multi criteria decision making problem used to determine the performance and rank the decision units. Multicriteria decision making problem always provide an alternative solution. It found difficult to get an alternatives that will meet all the criteria simultaneously, so a good compromise solution is preferred (Thiagarasa and Rengaraj, 2017) ^[2]. In present state of affairs this technique are gaining fame due to the complexity of the problems.

In this paper the assessment process generally followed by various steps (shown in fig 1).

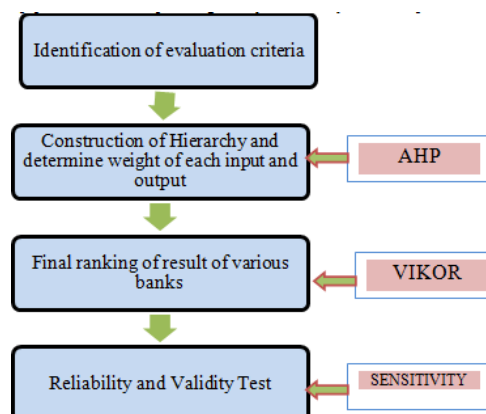


Fig 1: Step for evaluation

The previous studies measure the performance of various sector using Vikor, DEA and Topsis method in different area like supplier selection, robot spinning, chemical product, interval number, e- business and many more but least work is employed in area of public sector banks so Researchers in the present study attempt to measure the performance of the Indian Public Sector banks using combination of AHP and Vikor methods.

2. MCDM Technique

MCDM is a branch of operation research deals with complex decision making problem. It is also well known as Multi Criteria Decision Analysis. It involves both qualitative and quantitative factors (Mardani, et.al. 2015) ^[3].

The MCDM method used in study is explained in following sub sections:

2.1 AHP

AHP is multi-criteria decision-making tools recognized by Thomas L. Saaty (1980) [4]. In AHP model hierarchy and a pair wise matrix are developed using Saaty 1-9 preference scale and finally result are obtained. AHP also help to check the consistency of evaluated result.

Steps in AHP Process (Saaty, 1994) [5]

Step 1: Decision problem are Identified: This problem is identified with topmost part of hierarchy level.

Step 2: Develop hierarchy structure: hierarchy structure level is divided into three levels. Goal are set at topmost level than criteria are set than alternative were develop.

Step 3: Develop pair wise comparisons matrix. Pair wise comparison matrix is constructing with the help of expert scores. In this paper bank manager decision are taken as score

$$A_{n \times n} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \dots (1)$$

Step 4: Calculate normalised decision matrix

$$C_{ij} = \frac{a_{ij}}{\sum_{j=1}^n a_{ij}}, \dots (2)$$

"i = 1, 2, 3 ..., n, j = 1, 2, 3 ..., n,"

Step 5: Construct the weight normalised decision matrix

$$W_i = \frac{\sum_{j=1}^n C_{ij}}{\sum_{i=1}^n \sum_{j=1}^n C_{ij}}, i=1,2,3 \dots n, \dots (3)$$

$$W = \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix}, \dots (4)$$

Step 6: Calculate Eigenvector and Row matrix

$$E = \frac{N \text{th root value}}{E \text{ Nth root value}}, \dots (5)$$

$$\text{Rowmatrix} = \sum_{j=1}^n a_{ije} j, \dots (6)$$

Step 7: Calculate max Eigen value (λ_{\max})

$$\lambda_{\max} = \frac{\text{Rowmatrix}}{E}, \dots (7)$$

Step 8: Calculate the Consistency Index and Consistency Ratio

$$CI = \frac{\lambda_{\max} - n}{n - 1}, \dots (8)$$

$$\text{Where, } CR = \frac{CI}{RI}, \dots (9)$$

2.2 VIKOR

Vikor method was invented by Opricovic (1998) [6] it is a multicriteria decision making problem helps to resolve the complex systems. This technique utilizes to assess and ranks the alternatives. Computation of Vikor method involved following steps (Opricovic and Tzeng 2004):

Step 1: Formulate Decision matrix.

$$D = \begin{pmatrix} & C1 & C2 & \dots & Cj & \dots & Cn \\ A1 & X11 & X12 & \dots & X1j & \dots & X1n \\ A2 & X21 & X22 & \dots & X2j & \dots & X2n \\ \vdots & \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ Ai & Xi1 & Xi2 & \dots & Xij & \dots & Xin \\ \vdots & \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ Aj & Xj1 & Xj2 & \dots & Xjj & \dots & Xjn \end{pmatrix} \dots (10)$$

Where A_j denotes the alternative banks $j, j=1, 2, \dots, j$. C_j denotes i^{th} criterion, $i=1, 2, \dots, n$. X_{ij} indicating the performance rating of each alternatives A_j with respect to C_j criterion.

Step 2: Develop normalized matrix. In present paper vector normalisation is used where as Vector normalisation is the ration of

the sum of original normalisation value to the square root of the sum of original indicator values (Bulgurcu, 2012) [7].

$$R_{ij} = \frac{X_{ij}}{\sum_{j=1}^n X_{ij}} \dots (11)$$

Step 3: Calculate weight normalised matrix. Here in this paper weight are calculated with help of AHP model.

$$V_{ij} = W_i * R_{ij} \dots (12)$$

Step 4: Obtain F_{ij} . F_{ij} is the j^{th} criterion function of X_i alternative.

Whereas, $i = 1, 2, \dots, n$ the number of alternatives

$j = 1, 2, \dots, m$ the number of criteria.

Step 5: Calculate the maximum (f_j^*) and minimum (f_j^-) criterion function. Where $j = 1, 2, \dots, n$

$$f_j^* = \max_i f_{ij} = \max_i [F_{ij}] \text{ where } i = 1, 2, \dots, n] \dots (13)$$

$$f_j^- = \min_i f_{ij} = \min_i [F_{ij}] \text{ where } i = 1, 2, \dots, n] \dots (14)$$

Step 6: Compute utility and regret measures for all alternatives

$$\text{Utility measures } (S_i) = \sum_{j=1}^m W_j (f_j^* - f_{ij}) / f_j^* - f_j^- \dots (15)$$

$$\text{Regret measures } (R_i) = \max_j [W_j \frac{f_j^* - f_{ij}}{f_j^*} - f_j^-] \dots (16)$$

Step 7: Compute the VIKOR index value for each alternatives which can be expressed as follows:

$$Q_i = v \frac{(S_i - S^*)}{(S^- - S^*)} + 1 - v \frac{(R_i - R^*)}{(R^- - R^*)} \dots (17)$$

Where,

Q_i = VIKOR index value of i^{th} alternatives

$$S^* = \min_i S_i = \min [S_i]$$

$$S^- = \max_i S_i = \max [S_i]$$

$$R^* = \min_i R_i = \min [R_i]$$

$$R^- = \max_i R_i = \max [R_i]$$

where $i = 1, 2, \dots, n]$

v = weight for maximum value of group utility, usually value is taken as 0.5. In present study also v value is taken as 0.5.

$1-v$ = weight for individual regret.

Step 8: Finally ranking is done considering Q_i value. Less value specify better performance.

Sensitivity Analysis of MADM problem (Poovarasan and Robinson, 2015) [8]

Theorem: Change in Attribute Weight.

In multicriteria attribute decision making model, if the weight of P^{th} attributes changes Δ_p , then the weight attributes change by Δ_j (Poovarasan and Robinson, 2015) where,

$$\Delta_j = \frac{\Delta_p \cdot W_j}{W_p - 1}; j = 1, 2 \dots K, j \neq p \dots (18)$$

Proof: If the new weight of attributes is W'_j and the new weight of the P^{th} attribute changes as:

$$W'_p = W_p + \Delta_p \dots (19)$$

Then, the new weight of the other attributes would change as

$$W'_j = W_j + \Delta_j; j = 1, 2 \dots, K, j \neq p \dots (20)$$

And because the sum of weight must be 1 than:

$$\sum_{j=1}^K W'_j = \sum_{j=1}^K W_j + \sum_{j=1}^K \Delta_j \Rightarrow \sum_{j=1}^K \Delta_j = 0 \dots (21)$$

Therefore:

$$\Delta_p = \sum_{j=1, j \neq p}^K \Delta_j \dots (22)$$

Where,

$$\Delta_j = \frac{\Delta_p \cdot W_j}{W_p - 1}; i = 1, 2, \dots, K, j \neq p \dots (23)$$

Since:

$$-\Delta_p = \sum_{j=1, j \neq p}^K \Delta_j = \sum_{j=1, j \neq p}^K \frac{\Delta_p \cdot W_j}{W_p - 1}$$

$$= \frac{\Delta_p}{W_p - 1} \sum_{j=1, j \neq p}^K W_j \dots (24)$$

$$= \frac{\Delta_p}{W_p - 1} (1 - W_p) = -\Delta_p$$

Main result: In a MADM problem, if the weight of the P^{th} attributes Changes from W_p to W'_p as:

$$W'_p = W_p + \Delta_p \dots (25)$$

Then, the weight of other attributes would change as:

$$W'_j = \frac{1-W_p-\Delta_p}{1-W_p} \cdot W_j = \frac{1-W'_p}{1-W_p} \cdot W_j \quad j = 1, 2, \dots, K, j \neq p \dots (26)$$

Since, for $j = 1, 2, \dots, K, j \neq p$, We have:

$$\begin{aligned} W'_j &= W_j + \Delta_j = W_j + \frac{\Delta_p \cdot W_j}{W_p - 1} \\ &= \frac{W_j (W_p - 1) + \Delta_p \cdot W_j}{W_p - 1} \dots (27) \\ \Rightarrow W'_j &= \frac{(1-W_p-\Delta_p) \cdot W_j}{1-W_p} = \frac{1-W'_p}{1-W_p} \cdot W_j; j = 1, 2, \dots, k, j \neq p \dots (28) \end{aligned}$$

Then, new vector for weights of attributes would be $W'^t = (W'_1, W'_2, \dots, W'_k)$, that is:

$$W'_j = \begin{cases} W_j + \Delta_p & j = p \\ \frac{1-W'_p}{1-W_p} \cdot W_j & j \neq p, j = 1, 2, \dots, k. \end{cases} \dots (29)$$

$$W'_p = W_p + \Delta_p \Rightarrow \begin{cases} \text{if } W'_p > W_p \Rightarrow W'_j < W_j \\ \text{if } W'_p < W_p \Rightarrow W'_j > W_j \end{cases} \quad j = 1, 2, \dots, K, j \neq p \dots (30)$$

The sum of new weight of attributes that are obtained in (28) is 1, because:

$$\begin{aligned} \sum_{j=1}^k W'_j &= \sum_{j=1, j \neq p}^k W'_j + W'_p = \sum_{j=1, j \neq p}^k \frac{W_j (1 - W_p - \Delta_p)}{1 - W_p} + W_p + \Delta_p \\ &= \frac{(1 - W_p - \Delta_p)}{1 - W_p} \sum_{j=1, j \neq p}^k W_j + W_p + \Delta_p \\ &= \frac{1 - W_p - \Delta_p}{1 - W_p} \cdot (1 - W_p) + W_p + \Delta_p \\ &= 1 - W_p + W_p + \Delta_p = 1 \dots (31) \end{aligned}$$

3. Review of Literature

Prior researchers are using financial management tool ratio analysis to compute the efficiency of banks. In this paper, we make use of multi criteria decision making tools like AHP and Vikor method.

Opricovic and Tzeng (2004) [9] mean to create a comparative analysis of Vikor and TOPSIS to rank the different alternatives taken for the study. Fallahpour and Moghassem (2014) [10] utilize Vikor methodology to select and rank the appropriate setting in rotor spinning machine. Sensitivity analysis is done to know the stability of final ranking. Rao, Sai&Babu (2017) [11] Researcher aspire to assess the performance of 20 different suppliers by using entropy and Vikor method. Sayadi (2009) [12] used extended Vikor method with interval numbers. Wang and Chen (2014) [13] approaches to rank the performance of E-business project by using the Vikor and FAHP approach. Thipparat and Thaseepetch (2013) [14] aims to applied Vikor and AHP to measure management performance in the office of president. Triantaphyllou and Mann (1995) [15] says that AHP is used to solve a critical problem.

4. Methodology of Study

Authors in present paper aspires to measure the performance and rank the Indian Public sector bank using combination of AHP-VIKOR analysis and they also aim to test reliability and validity of result using Sensitivity analysis. In the present paper, multiple outputs and inputs are involved like Total Assets (X1), Deposits (X2), Operating expenses (X3), Operating Profit (Y1), Investment (Y2), and Loan and Advances (Y3). Data are totally based on secondary sources which were collected from various banks annual reports. Only primary data are collected from interaction with 5 to 6 bank managers to develop the matrix in AHP.

5. Result and Discussion

26 banks data are taken for the year 2015-16 was acquired from the different published report; AHP analysis determine the different weights for Variables using equation (3) and (4) (shown in Table 1). For this, bank managers were asked about the level of significance of each factor with respect to each other. In present study consistency ratio for both inputs and outputs is less than 0.10 evaluated using equations (9), so we preceded our study further.

Table 1: Weights of Criteria and Alternatives

Inputs	Weight	Outputs	Weight
X1	0.546	Y1	0.264
X2	0.384	Y2	0.656
X3	0.069	Y3	0.079

Sources: Own Calculation

Consistency ratio for inputs and outputs are 0.093 and 0.019. Table 2 shows different weights are assigned to inputs and outputs are 0.546, 0.384, 0.069, 0.264, 0.656, and 0.079. These weights are further operated in Vikor analysis.

Application of VIKOR ANALYSIS

In current study decision matrix were banks original data which were normalized using equation (11), then these normalized data are multiplied with AHP weight to obtain weighted normalised data shown in Table (2). AHP weight is calculated refereeing equation 3 and 4 and result is illustrated in Table (1). Finally ranks is computed using Vikor Index (Qi) shown in Table (6).

Table 2: Weighted Normalised Matrix

After normalised matrix next weight normalised matrix is calculate (we multiply weight (w) with each column of normalised matrix.

Weight	0.546	0.384	0.069	0.264	0.656	0.079
DMU#	X1	X2	X3	Y1	Y2	Y3
1	0.05009	0.03579	0.00410	0.01672	0.06064	0.00569
2	0.01974	0.03040	0.00417	0.02140	0.05162	0.00531
3	0.07351	0.09647	0.01421	0.06600	0.15126	0.01810
4	0.03782	0.03916	0.00716	0.01559	0.07588	0.00653
5	0.04082	0.00187	0.00743	0.00786	0.29626	0.03335
6	0.02474	0.03500	0.00524	0.02237	0.05333	0.00618
7	0.04063	0.03644	0.00493	0.01989	0.06292	0.00604
8	0.01607	0.01764	0.00271	0.00971	0.03456	0.00266

9	0.01619	0.01231	0.00239	0.00677	0.01928	0.00219
10	0.09097	0.08369	0.01067	0.03861	0.13637	0.01318
11	0.05875	0.05978	0.00898	0.03049	0.08548	0.01088
12	0.00873	0.01640	0.00293	0.01245	0.02375	0.00296
13	0.02982	0.03110	0.00455	0.01638	0.05087	0.00524
14	0.46977	0.30188	0.05953	0.23371	0.45718	0.05939
15	0.10360	0.10013	0.01271	0.04763	0.11542	0.01557
16	0.02398	0.02393	0.00392	0.01779	0.03642	0.00451
17	0.02593	0.02030	0.00276	0.00979	0.04286	0.00276
18	0.02729	0.04565	0.00736	0.01797	0.06576	0.00817
19	0.05123	0.03613	0.00405	0.01947	0.08047	0.00511
20	0.10198	0.08948	0.01331	0.03261	0.11389	0.01457
21	0.02443	0.02424	0.00364	0.01267	0.03472	0.00436
22	0.03274	0.02048	0.00323	0.00500	0.03376	0.00334
23	0.01906	0.01592	0.00197	0.00686	0.02649	0.00259
24	0.06557	0.04643	0.00906	0.01428	0.08511	0.00730
25	0.13364	0.04635	0.00588	0.02901	0.09487	0.00876
26	0.02480	0.02188	0.00297	0.00837	0.04010	0.00361

Sources: Own Calculation

Table 3: Value of Maximum criterion function (f_j^*)

X1	X2	X3	Y1	Y2	Y3
0.86	0.78	0.86	0.88	0.69	0.75
039	614	280	528	692	180

Sources: Own Calculation

Table 4: Value of Minimum criterion function (f_j^-)

X1	X2	X3	Y1	Y2	Y3
0.01	0.00	0.02	0.01	0.02	0.02
599	486	859	893	939	771

Sources: Own Calculation

Interpretation:

In a Vikor method for all criterion function best (f_j^*) and worst (f_j^-) value are determined which are the positive and negative ideal solution of j th criteria calculated using equation (13) and (14) (shown in Table 3 and 4). For year 2015-16 the Maximum criterion function (f_j^*) for inputs X1, X2, X3 and outputs Y1, Y2, Y3 are (0.86039, 0.78614, 0.86280, 0.88528, 0.69692, 0.75180). Likewise, the Minimum criterion function (f_j^-) for inputs X1, X2, X3 and outputs Y1, Y2, Y3 are (0.01599, 0.00486, 0.02859, 0.01893, 0.02939, 0.02771).

Table 5: Value of Utility measure (Si) and Regret measure (Ri)

DMU#	DMU	Utility measure (Si)	Regret measure (Ri)
1	Corporation Bank	1.822724	0.594047
2	Andhra Bank	1.874137	0.607565
3	Punjab National Bank	1.495446	0.469291
4	Indian Overseas Bank	1.806594	0.571209
5	State Bank of	1.492196	0.508

Patiala			
6	Allahabad Bank	1.856142	0.60499
7	Oriental Bank Of Commerce	1.824555	0.590635
8	State Bank of Travancore	1.939267	0.633121
9	State Bank of Mysore	1.973266	0.656
10	Canara Bank	1.556068	0.480599
11	Union Bank of India	1.715642	0.556827
12	State Bank of Bikaner and Jaipur	1.961896	0.649313
13	Indian Bank	1.867847	0.608677
14	State Bank of India	0.00000	0.00000
15	Bank of Baroda	1.535293	0.511978
16	State Bank of Hyderabad	1.905733	0.630327
17	United Bank of India	1.911462	0.620687
18	Syndicate Bank	1.820658	0.58638
19	UCO Bank	1.788945	0.564341
20	Bank of India	1.571139	0.514277
21	Bank of Maharashtra	1.913786	0.632878
22	Dena Bank	1.920963	0.63432
23	Punjab & Sindh Bank	1.954282	0.645203
24	Central Bank of India	1.748757	0.557385
25	IDBI Bank	1.638428	0.542772
26	Vijaya Bank	1.91513	0.624822

Sources: Own Calculation

Interpretation:

In Vikor analysis the value of Utility measure (Si) and Regret measure (Ri) is resolute (shown in Table 5). The result of Utility measure (Si) and Regret measure (Ri) shows that State Bank of India is considered as a most efficient bank with minimum utility and regret value (0.00000)

Table 6: Value of VIKOR Index (Q_i)

DM U#	DMU	Q_i	Rank
1	Corporation Bank	0.914635	14
2	Andhra Bank	0.937965	17
3	Punjab National Bank	0.736618	2
4	Indian Overseas Bank	0.893141	11
5	State Bank of Patiala	0.765298	4
6	Allahabad Bank	0.931443	15
7	Oriental Bank Of Commerce	0.912497	13
8	State Bank of Travancore	0.973947	23
9	State Bank of Mysore	1.00000	26

	sore		
10	Canara Bank	0.760598	3
11	Union Bank of India	0.859132	8
12	State Bank of Bikaner and Jaipur	0.992022	25
13	Indian Bank	0.937219	16
14	State Bank of India	0.00000	1
15	Bank of Baroda	0.779251	5
16	State Bank of Hyderabad	0.963321	20
17	United Bank of India	0.957424	18
18	Syndicate Bank	0.908267	12
19	UCO Bank	0.883433	10
20	Bank of India	0.790086	6
21	Bank of Maharashtra	0.967305	21
22	Dena Bank	0.970223	22
23	Punjab & Sindh Bank	0.986961	24
24	Central Bank of India	0.867948	9
25	IDBI Bank	0.828854	7
26	Vijaya Bank	0.961506	19

Sources: Own Calculation

Interpretation:

Table 6 result exemplify that State Bank of India (DMU 14) is the most leading alternatives having the lowest Vikor Index 0.00000, next to it are Punjab National Bank (0.736618) and Canara Bank (0.760598). So, State Bank of India is chosen as top performing bank among 26 alternatives and ranked as 1, as well becomes the benchmark for other DMUs as in Vikor Method if the vikor index value is lower than it is regarded as best one among others.

Sensitivity Analysis for Vikor Method:

To make the result evaluation more sensitive and accurate the sensitivity analysis is executed for the weighting vectors in order to know how much deviation is taken place in each case when weight value is changed. All Steps are equal to evaluate Vikor Index only weights are changed.

Currently we assumed that the weight of 2nd alternative (which is evaluated with help of AHP) will increase by.

$$\Delta_p = 0.057$$

$$W'_p = W_p + \Delta_p$$

$$= 0.384 + 0.057$$

$$= 0.441 \quad \dots \text{(calculated using equation 25)}$$

Then, the weight of other attributes would change as:

$$W'_j = \frac{1 - W'_p}{1 - W_p} \cdot W_j$$

$$= \frac{1 - 0.441}{1 - 0.384} \cdot W_j$$

$$= \left(\frac{0.559}{0.616} \right) W_j = 0.9075 W_j$$

W_j = AHP weight

Therefore, $W'_j = (0.496, 0.349, 0.063, 0.240, 0.595, 0.072)$.

Table 7: Value of VIKOR Index (Q_i) after Changing the Weight Value

DMU #	DMU	Q_i	Rank
1	Corporation Bank	0.91465	14
2	Andhra Bank	0.93797	17
3	Punjab National Bank	0.73719	2
4	Indian Overseas Bank	0.89315	11
5	State Bank of Patiala	0.76602	4
6	Allahabad Bank	0.93145	15
7	Oriental Bank Of Commerce	0.91251	13
8	State Bank of Travancore	0.97395	23
9	State Bank of Mysore	1.00000	26
10	Canara Bank	0.76062	3
11	Union Bank of India	0.85914	8
12	State Bank of Bikaner and Jaipur	0.99202	25
13	Indian Bank	0.93723	16
14	State Bank of India	0.00000	1
15	Bank of Baroda	0.77925	5
16	State Bank of Hyderabad	0.96332	20
17	United Bank of India	0.95743	18
18	Syndicate Bank	0.90827	12
19	UCO Bank	0.88346	10
20	Bank of India	0.79009	6
21	Bank of Maharashtra	0.96731	21
22	Dena Bank	0.97023	22
23	Punjab & Sindh Bank	0.98696	24
24	Central Bank of India	0.86796	9
25	IDBI Bank	0.82887	7
26	Vijaya Bank	0.96151	19

Sources: Own Calculation

Interpretation:

When we change the AHP weight value of inputs X1, X2, X3 and outputs Y1, Y2, Y3 to (0.496, 0.349, 0.063, 0.240, 0.595, and 0.072) (presented in Table 7) the result of sensitivity analysis shows the same result as that of VIKOR analysis, State Bank of India (DMU 14) is the most prevailing alternatives having the lowest Vikor Index 0.00000, next to it are Punjab National Bank (0.73719), and Canara Bank (0.76062) with 2nd and 3rd position. Finally, study interprets that result obtained were consistent and stable.

6. Conclusion

In cut-throat competition computing the performance and taking an appropriate decision is the key feature for the expansion and intensification. The proposed work used AHP and Vikor method to measure the performance of Indian public sector bank and rank them according to their performance. Sensitivity analysis is used in a Vikor method. The study involves an epitome structure with help of AHP-VIKOR analysis. AHP is used to determine a diverse weight for each input and output criteria and these weights are further utilized while figuring out the rank with help of VIKOR method.

VIKOR result indicate State Bank of India is found to be a most competent bank with minimum VIKOR Index (0.000) for year 2015-16 next to it are Punjab National Bank (0.736618), and Canara Bank (0.760598). To make the result evaluation more sensitive and accurate the sensitivity analysis is carried out. The result of sensitivity analysis shows the same result as that of VIKOR analysis.

Research extent a scope for future research, the method used in the present study can be Compare with other MCDM methods and also taking into consideration other input and output criteria. Further research can be extended for the additional time period.

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