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Stock Index Ranking and Performance Evaluation of Shanghai Stock Exchange (SSE) Using AHP and TOPSIS Method

Sanjay Kumar Singhai[1*], Vineet Kumar Awasthi[2]

[1]Dept of Electrical Engineering, Govt. Engineering College, Bilaspur, India
[2]Dept. of IT, Dr. C. V. Raman University, Bilaspur, India

[*]*Corresponding Author: ersanjaysinghai@gmail.com*

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Abstract— Stock Index selection process is tough in financial domain and complicated in decision making process, especially when selected criterion is confecting in nature. Multi criteria decision-making (MCDM) methods like Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are most commonly used method for decision making process in financial domain. This paper utilizes AHP and TOPSIS method for ranking of indices. Three financial year data of five stock indices from Shanghai Stock Exchange (SSE) with four criteria are considered in stock index ranking process. Experimental result reveals that SSE IT TELECOMMUNICATION index is preformed consistently well for all three financial years in case of both AHP and TOPSIS method.

Keywords—Analytical Hierarchy Process (AHP),Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

I. Introduction and Related Work

An index is a collection if multiple stock of an institute or individual. An index is more reliable than individual stock because of diversification of funds, to find good return. Investment in an index may be less risky with lest return as compare to single stock but selection of best index form the group is a very challenging task for decision maker, fund manager or invertors. Due to tough business environment and high market competition financial manager try their best to make ultimate plans for the selection of best stock index. The selection of best stock index can be effectively solved using ranking of stock index. Stock Index ranking is the process of ranking indices that is used for decision making for investors on the basis of maximum annual return and minimum risk. Stock index ranking is done with fine balance between risk and return. Markowitz (1952) [1] proposed a framework for mean-variance portfolio optimization. Stock index selection can be viewed as multi criteria decision making (MCDM) problem, where the criterion is conflicting in nature. One of the most popular MCDM techniques is Analytical Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. Author [2] deals with the problem of finding the optimum site for a railway station for the city of Mashhad, northeast Iran, by using the methods of analytical hierarchy process (AHP) and data envelopment analysis (DEA). This paper identifies a four-level hierarchy model for the railway station site-selection problem. The model uses four main criteria: (1) rail-related, (2) passenger services, (3) architecture and urbanism, and (4) economics. Author [3] evaluates alternative fuels for the Greek road transport sector, using the AHP. AHP is very popular MCDM method utilized by the researchers in many domains like engineering, science etc.. Author [4][5][6] used Fuzzy AHP and TOPSIS method for the ranking of teacher's performance in different educational fields. Another [7] has used multi-criteria decision approach for choosing optimal blanching-freezing system. There are some other researchers [8][9] who have used AHP and TOPSIS methods for performance evaluation in healthcare industry. However very less literatures relate to application of AHP in financial domain are available. AHP may be one of the choices for the researchers to be utilized for portfolio selection. A portfolio may have many criterion like high, low, dividend, yearly return, P/E ratio etc. but all these criterion may be of conflicting in nature, due to this it is a tedious task to decide the rank of the portfolio.

TOPSIS method has been used popularly not only in financial domain but in many other domains like sports [10], product quality testing [11] etc. For the purpose of selecting stock index to create portfolio, TOPSIS and other MCDM methods are being used by many researchers. Another author [12] presents the modifications in the algorithm of Hwang and Yoon to solve the problem of rank reversal. Rank reversal is an event occurs when a new alternative encounter at the middle of the selection process of an alternative from multiple choices. Authors [13] proposed a new alternative method based on TOPSIS method named as A-TOPSIS for the ranking and comparing algorithms. The ranking of the algorithm with respect to the criteria are done by means of a decision matrix in terms of mean values and standard deviations. Another author [14] presents review paper of on application of TOPSIS method in different domains. They reviewed almost 266 scholarly papers from 103 journals since the year 2000, separated into nine application areas. Author [15] has also used the TOPSIS method to find the pollution levels in economy sectors of Iran using Input-Output analysis for sustainable development. TOSIS method was also used by [11] to evaluate the quality credit evaluation of air-conditioning market in China for the performance valuation in market. Selection of a foreign player has also done through TOPSIS method [10]. In the financial domain TOPSIS method has been used for the ranking stock index [16] where performance of thirteen technical firm of Istanbul Stock Exchange (ISE) is evaluated. The above study of literature shows that TOPSIS and its variations suggested by many authors may be the best technique to select best alternative especially when criterion are conflicting in nature.

In this research AHP and TOPSIS method are used for stock index ranking of Shanghai Stock Exchange (SSE). Three years of financial data of five stock indices with four criterion is used in experimental work for index ranking and performance evaluation of indices.

II. METHODOLOGY

1. Analytical Hierarchical Process (AHP) - AHP is the most popular MCDM method proposed by Satty [17], which involves structuring multiple choice criteria into a hierarchy, assessing relative importance of criteria, comparing alternatives for each criterion and then evaluating overall ranking of the alternatives. A root method (Also called the geometric mean method) is used in AHP method described as follows [18]:

Step 1: Determine alternative and criteria for ranking.

Step 2: Data should be normalized. Many methods are available for normalization. We divide all value of a column (A) with max value of that column. The calculation is done through following formula:

$$A_i = (A_i / \max(A)) \quad (1)$$

Here i^{th} value is divided by the maximum value of corresponding column for normalized value

Step 3: in this step pair-wise comparison matrix is constructed for relative importance between criterion. Saaty's nine point scale is used for assigning numeric weights between criterion. An attribute compared with itself is always assigned the value "1". The pair–wise comparison of attribute i with attribute j yields a square matrix $B_{M\times M}$ with M criterion where a_{ij} denotes the comparative importance of attribute i with respect to attribute j. In the matrix b_{ij}=1 when i=j and

$$b_{ji} = \frac{1}{b_{ij}}$$

Relative normalized weight (W_j) of each attribute by following steps:

(i) Evaluate geometric mean of the i^{th} row, and

(ii) Normalizing the geometric means of rows in the comparison matrix through following equation.

$$GM_j = \left[\prod_{i=1}^{M} b_{ij}\right]^{1/M} \quad (2)$$

$$\text{and } W_j = GM_j \Big/ \sum_{i=1}^{M} GM_j$$

Calculate matrices E_1 and E_2 such that $E_1(A_3)=A_1 \times A_2$ and $E_2= A_3/A_2$, where $A_2=[w_1,w_2,\ldots\ldots,w_i]$.

Determine the maximum Eigen value λ_{max} that is the average of matrix A_4. Calculate the consistency index

$$CI = (\lambda_{max}\text{-}M) \Big/ (M\text{-}1) \quad (3)$$

Obtain the random index (RI) for the number of attributes used in decision making [11]. Calculate the consistency ratio

$$CR=CI/RI \quad (4)$$

Step 4: In this step, we need to obtain the overall or composite performance scores for the alternatives by multiplying the relative normalized weight (W_j) of each attribute (obtained in step two) with its corresponding normalized object data for each alternative and summing over the attributes for each alternative.

2. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) - TOPSIS is another MCDM method praposed by Hwang et al. [19] which is also used as an alternetive of AHP method. However TOPSIS can be inigrated with AHP where criterian weightes caliculated by AHP can be utilizes by TOPSIS to find out final value for available alternetives. The steps of TOPSIS [20] are as follows:

Step 1:- Calculate criterion weights or inherited weight by other method like AHP.

Step 2:- Obtain the decision matrix after using a numerical scale for intangibles.

Step 3:-Obtain the normalization decision matrix R, using the relationship.

$$r_{ij} = x_{ij} \Big/ \left[\sum_{i=1}^{M} x_{ij}^{\ 2}\right]^{1/2} \quad (5)$$

Step 4:- Obtain the weighted decision matrix V by multiplying each column of R by the corresponding weight. These weighted are being obtained through the method of AHP previously mentioned.

Step 5:- Obtain the ideal (A*) and the negative ideal (A^-) solution from the weighted decision matrix V. Where the A* are the set of positive ideal values of each criteria and A^- are the set of negative ideal values of each criteria.

Step 6:- Compute the separation measures from the (S*) and the negative ideal (S^-) solution for all the alternatives,

For i = 1....m.

$$S_i^* = \sqrt[2]{\sum_{j=1}^{n}(v_{ij}-v_j^*)^2} \quad (6)$$

$$S_i^- = \sqrt[2]{\sum_{j=1}^{n}(v_{ij}-v_j^-)^2} \quad (7)$$

Step 7:- For the each alternative determine the relative closeness to the ideal solution

(C_i*, i = 1.....m) As

$$C_i^* = S_i / (S_i^* + S_i^-) \quad (8)$$

Step7:- Determine the preference order by arranging the alternative in the descending order of C_i*, i=1...m.

III. EXPERIMANTAL WORK

Five indices SSE 380 IT Industry (I_{IT}), SSE 50 (I_{50}), SSE 180 (I_{180}), SSE 380 Telecommunication ($I_{TELICOMMUNICATION}$) and SSE B Share($I_{B\text{-}SHARE}$) with four criterion High, Low, Open and Close of SSE of year 2017-18 downloaded from sse.com[21]. New important criterion Annual Return (C1), Standard Deviation (C2) and Beta Value (C3) are calculated from index values downloaded from SSE.Com for finding ranks of stock index using AHP and TOPSIS method. The normalized index value of year 2017-18 is calculated using equation 1 and presented in Table 1. The major task for index ranking using AHP is to calculate normalized weight for three new criterions. A pair wise comparison matrix is created using Saaty's 9 point scale [17] and then GM, CI and CR are calculated. The calculation of criterion weight for Annual Return (C1), Standard Deviation (C2) and Beta Value (C3) has already done by Hota et al. [22] where the value of CR is less than 0.1 that is in acceptable range. Resultant weight for criterion is presented in Table 2**.** Then the AHP weight is calculated as mentioned in step 4 of AHP using criterion weight. The final AHP weight and rank of each stock index is presented in Table 3.

Table 1: Normalized SSE Index Value of Year 2017-18 for AHP

Index	**Annual Return (%)**	**Daly Standard Deviation**	**Beta Value**
I_{IT}	0.017	0.763	1.000
I_{50}	1.000	0.425	0.695
I_{180}	0.662	0.369	0.710
$I_{TELICOMMUNICATION}$	0.932	1.000	1.243
$I_{B\text{-}SHARE}$	-0.377	0.365	0.574

Table 2: Weights of Corresponding Criteria calculated through AHP

C1	**C2**	**C3**
0.436	0.240	0.324

Table 3: Obtained Rank using AHP of Financial Year 2017-18

Index	**Final AHP Weight**	**Rank**
I_{IT}	0.514	4th
I_{50}	0.763	2nd
I_{180}	0.607	3rd
$I_{TELICOMMUNICATION}$	1.049	1st
$I_{B\text{-}SHARE}$	0.109	5th

In next phase, another popular MCDM technique (TOPSIS) is applied for SSE index ranking of year 2017-18. Normalized stock index value is calculated using equation 5 and presented in Table 4. The weighted decision matrix V is calculated and presented in Table 5 where positive ideal solution (PIS) and negative ideal solution (NIS) as highlighted in bold and underlined letters respectively**.** Separation measures of each alternative are calculate for PIS (S_i^+) and NIS (S_i^-) is calculated using equation 6 and 7 and presented in Table 6**.** Finally the relative closeness value is calculated using equation 8 and rank of six stock indices are obtained and presented in Table 7.

Table 5: Normalized SSE Index Value of Year 2017-18 for TOPSIS

Index	**Annual Return (%)**	**Daly Standard Deviation**	**Beta Value**
I_{IT}	0.011	0.535	0.655
I_{50}	0.639	0.298	0.455
I_{180}	0.423	0.259	0.465
$I_{TELICOMMUNICATION}$	0.595	0.702	0.071
$I_{B\text{-}SHARE}$	-0.241	0.256	0.376

Table 4: Weighted decision matrix (V)

Index	**Criteria**		
	C1	**C2**	**C2**
I_{IT}	0.005	0.128	0.212
I_{50}	0.279	0.072	0.147
I_{180}	0.185	0.062	0.151
$I_{TELICOMMUNICATION}$	**0.260**	0.168	**0.023**
$I_{B\text{-}SHARE}$	-0.105	**0.061**	0.122

Table 7: Separation Measurers

	A1	**A2**	**A3**	**A4**	**A5**
S_i^+	0.340	0.125	0.158	0.109	0.396
S_i^-	0.110	0.464	0.303	0.413	0.112

Table 8: Obtained Rank using TOPSIS of Financial Year 2017-18

Index	**RC*(Relative Closeness)**	**Rank**
I_{IT}	**0.244**	4th
I_{50}	**0.788**	2nd
I_{180}	**0.657**	3rd
$I_{TELICOMMUNICATION}$	**0.792**	1st
$I_{B\text{-}SHARE}$	**0.221**	5th

The comparative rank of year 2016-17 for AHP and TOPSIS method is presented in Table 9. This table clearly shows that both AHP and TOSIS methods are producing same rank for the entire index.

Table 9: Comparative Rank of AHP and TOPSIS method for Year 2017-18

Index	Rank	
	AHP	TOPSIS
I_{IT}	4th	4th
I_{50}	2nd	2nd
I_{180}	3rd	3rd
$I_{TELICOMMUNICATION}$	1st	1st
$I_{B\text{-}SHARE}$	5th	5th

The entire process as explained above for AHP and TOPSIS method is again applied for stock index data of the financial year 2016-2017 and 2015-2016 and resultant rank of index are presented in Table 9.

The consistent performance of indices over the years for decision making process is checked using comparison of rank of the indices in three consecutive financial years presented in Table 10. From the Table 10 it is clear that SSE Telecommunication is continuously performing well by holding first rank in two resent years (2017-18 & 2016-17) and holding second rank in year 2015-16. On the other hand SSE 50 is second ranked index in two resent years (2017-18 & 2016-17). Rank of other index is also consistence with low rank except in year 2015-16.

The rank of the portfolio of three consecutive financial years may be compared to check the consistent performance of the portfolios over the years for decision making process, rank of these three financial years are presented in Table 6, from which it is clear that S&P BSE SENSEX is continuously performing well by holding first rank in all three years. Rank of other portfolios are however not consistent but S&P MID CAP, S&P BSE200 and S&P BSE500 are gaining same ranks at least in two financial years out three however portfolio for 2nd and 5th rank not consistent over the years.

IV. Performance Analysis of Stock Index

In order to find the strength in the performance of a stock index rank of three year financial data (2017-18, 2016-17 & 2015-16) are presented in table 10. As shown through the table SSE 380 TELECOMMUNICATION is continuously performing well by holding 1st rank for two recent year (2017-18, 2016-17) and slight changes in year 2015-16 while SSE B SHARE is consistently performing worst with lowest ranking (5th rank).

Table 11: Year wise comparison of stock indices

Index	2018-17		2016-17		2015-16	
	AHP	TOPSIS	AHP	TOPSIS	AHP	TOPSIS
I_{IT}	4th	4th	4th	4th	4th	4th
I_{50}	2nd	2nd	2nd	2nd	3rd	3rd
I_{180}	3rd	3rd	3rd	3rd	5th	5th
$I_{TELICOMMUNICATION}$	1st	1st	1st	1st	2nd	2nd
$I_{B\text{-}SHARE}$	5th	5th	5th	5th	1st	1st

V. Conclusion

Ranking of stock index is important for the selection of best index that causes best investment and return in stock market. The task of stock index ranking is tough because of conflicting criterion of index. MCDM based techniques are one of the best techniques for stock index ranking that efficiently manages conflicting criterion. This paper applied two MCDM techniques, AHP and TOPSIS for stock index ranking of Shanghai Stock Exchange (SSE). From the experimental result SSE IT TELECOMMUNICATION is identifies as best index by holding 1st rank in recent years.

REFERENCES

[1] H.M. Markowitz, "Portfolio selection", Journal of Finance ,Vol.**7** , pp.77-91, **1952** .

[2] Mohajeri , R. A. Gholam , "Railway station site selection using analytical hierarchy process and data envelopment analysis", Computers & Industrial Engineering, Vol. **59**, pp.**107–114**, **2010**.

[3] Y. S. Nes_e, B. Ali, Cengiz Kahraman, "Fuzzy performance evaluation in Turkish Banking Sector using Analytic Hierarchy Process and TOPSIS", Expert Systems with Applications, Vol.**36**, pp. **11699–11709**, **2019**.

[4] H.S. Hota, L.K.,Sharma and S. Pavani, "Fuzzy TOPSIS Method Applied for Ranking of Teacher in Higher Education", Intelligent computers, Networking & Informatics, Vol.**243**, pp. **1225-1232**, **2014**.

[5] L.K. Sharma and S. Pavani S., "A Group Experts Evaluation for Teachers by Integrating Fuzzy AHP Fuzzy TOPSIS methods", IEEE MOOC innovation 7 tech. In education (MITE), pp.**85-90**, **2013**.

[6] H.S.Hota, S. Pavani, "Evaluate Teachers Ranking in Fuzzy AHP Techniques", IJSCE,Vol.**2**, pp.**2231-2307**, **2013.**

[7] M. D'Amore, A. Polonara, "A Multi-Criteria Decision Approach to Choosing The Optimal Blanching-Freezing System", Journal of Food Engineering, Vol.**63**,pp. **253-263**, **2004**.

[8] G. Buyukozkan ,G. Cifci, S. Guleryuz , "Strategic analysis of healthcare service quality using fuzzy AHP methodology", Expert Systems with Applications Vol.**38**,pp **9407–9424**,**2011**.

[9] G. Buyukozkan, G. Cifci , "A combined fuzzy AHP and fuzzy TOPSIS based strategic analysis of electronic service quality in healthcare industry", Expert Systems with Applications, Vol. **39**,pp. **2341–2354**, **2012**.

[10] X. Zhongyou, "Study on the Application of TOPSIS Method to the Introduction of Foreign Players in CBA Games", Physics Procedia,Vol **33**, pp. **2034-2039**, **2012**.

[11] X. Zhu , F. Wang, C. Liang , J. Li., X. Sun X., "Quality credit evaluation based on TOPSIS: Evidence from air-conditioning market in China", Procedia Computer Science, Vol. **9**, pp.**1256-1262**, **2012**.

[12] M.T.García-Cascales, M.T. Lamata M.T., "On rank reversal and TOPSIS method", Mathematical and Computer Modelling, Vol. **56**, pp. **123–132**, **2012.**

[13] R.A Krohling., A.G.C. Pacheco, "A-TOPSIS – An approach Based on TOPSIS for Ranking Evolutionary Algorithms", Procedia Computer Science, Vol.**55**, pp.**308-317**, **2015**.

[14] M. Behzadian, S.K.Otaghsar, M. Yazdan, J.Ignatius, "A state-of the-art survey of TOPSIS applications", Expert Systems with Applications, Vol. **39**, pp.**13051–13069**, **2012**.

[15] Z.Ahmadi, M.R.Dehaghi, M.E.Meybodi, M. Goodarzi, M. Aghajani, "Pollution Levels in Iranian Economy Sectors Using Input-Output Analysis and TOPSIS Technique: An Approach to

Sustainable Development", Procedia - Social and Behavioral Sciences, Vol. **141**, pp.**1363 – 1368**, **2014**.

[16] B. Bulgurcu, "Application of TOPSIS Technique for Financial Performance Evaluation of Technology Firms in Istanbul Stock Exchange Market", Procedia - Social and Behavioral Sciences, Vol. **62**, pp. **1033-1040**, **2012**.

[17] T.L.Saaty , "Decision Making with Dependence and Feedback: Analytic Network Process", RWS Publications, Pittsburgh, **2001**.

[18] H.S.Hota, D.K. Sharma, V.K. Awasthi, "AHP Method Applied for Portfolio Ranking of Various Indices and Its Year Wise Comparison", International Journal of Research Studies in Computer Science and Engineering (IJRSCSE) August, pp **53-57**, **2015**.

[19] C.L Hwang, K.P. Yoon, "Multiple attributes decision making methods and applications", Berlin: Springer-Verlag, **1981**.

[20] H.S.Hota, S.K. Singhai, V.K. Awasthi , APPLICATION OF TOPSIS METHOD FOR STOCK INDEX RANKING, Journal of Global Information Technology,Vol. **11**, pp. **37-43**, **2016**.

[21] Web source (2018). www.SSE.Com last accessed on January **2018**.

[22] H.S.Hota, V.K. Awasthi, S.K. Singhai, An Integrated Three Tier Architecture of AHP-GP for Stock Portfolio Management, International Journal of Pure and Applied Mathematics Volume 118 Issue **19**, pp. **115-123**, **2018**.

