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STOCK MARKET COMPONENT ANALYSIS USING AHP AND MARKOVCHAIN

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ABSTRACT

Stock Market is a huge area to perform Research works. Prediction is one of the most important factors in Stock Markets, since the shares of the companies are increasing or decreasing day by day and it is necessary to safeguard the money of the investors. In this paper we have focused on pharmaceutical field by selecting 15 companies within this field. In order to predict the best performing company, AHP is applied and hence the companies are ranked according to their performances. AHP consists of Criteria's and Alternatives. Fundamental parts of the companies are taken as Criteria's. Technical Part of the Company is also considered and in order to select the best company Artificial Intelligence is applied after combining both the results of Fundamental and Technical parts. Application of Eigen Vector under Markov Chain is applied to the result of AHP and share holding pattern of the investor after a year is predicted.

Keywords: AHP, artificial intelligence, fundamental parts, technical parts, eigenvector-markov chain.

INTRODUCTION

Stock Market is a great field for the investors to make money. For the past few decades different types of methodologies were emerging to predict the performance of the companies and their prices in the market. To perform analysis in the field of stock market we have two types of analysis named Fundamental analysis and Technical analysis. There are lot of sectors in stock market like Steel sector, Cement sector, Sugar sector, Petrochemical sector and Pharmaceutical sector. To analyse the recital of 27 Iran Cement firms, the author has applied Fuzzy AHP-VIKOR method while FAHP is used to establish the weights of criteria and VIKOR method is used for ranking the firms [1]. 7 petrochemical industries were evaluated by forming a framework in order to make good decision by applying the combination of Fuzzy and AHP [3]. In this paper we have focused our research work on Pharmaceutical field. Companies like Glenmark, Cadila, Ranbaxy, Merck, Sun Pharma, Strides Arcolab, Cipla, FDC, Aurobindo, Torrent, Dr.Reddy's, Divi's Lab, Natco, Orchid and Pfizer were considered for analysis. In our data set fundamental attributes like Probability of Bankruptcy, Z-Score, Total Debit, Bonus, Cash per Share, Book Value per Share, Operating Margin, Price to Earnings and Revenue were taken for analysis. The values were taken from the website named www.macroaxis.com. Two methodologies like Analytic Hierarchy process (AHP) and Eigen Vector application in Markov Chain is applied to the training set in order to guide the investors in a right manner so that they can conclude in which pharmaceutical company they can invest their earnings. AHP is a hierarchical tree with Criteria's and Alternatives. In terms with AHP, the fundamental attributes were termed as Criteria's and the Pharmaceutical Companies were termed as Alternatives. Supply chain crisis was

analysed through AHP with the help of five alternatives and after applying AHP 16 risk factors were found by the authors [5]. The purpose of applying AHP is to rank the alternatives. AHP has good classification power, to identify whether a product comes under Make-to-order or Make-to-stock and is combined with SWOT methodologies. Thus classification is done accurately with the help of this hybrid methodology [12]. Before ranking the alternatives, the Criteria's are first ranked and is done by making judgments. In order to make sustainable supplier selection via social parameters, AHP is used as a judgment making method thus integrating a mixture of social dimensions into the field of supplier chain [4]. Pairwise comparisons play a vital role in AHP. Intellectual Capital (IC) management is one of the fundamental factors when we consider business environments. In order to assess the importance of IC Components, Fuzzy and AHP is applied as a combination [6]. A decision support system was proposed in order to find the strategies of the managements. Decision support system incorporates AHP-Fuzzy evaluation approach, thus resource managers are combined with economic and ecosystem outcomes [7]. In order to validate the designs in electrical appliances company, Fuzzy Analytic Hierarchy Process was proposed as a multi-criteria inventory classification system [8]. Good decisions rely on the situation of future and these situations vary from time to time. Three ways are present to handle vibrant decisions. They are including a different factor which has the ability to change over a time, making pairwise comparisons and deriving functions from these pairwise comparisons [2]. Investors get struggled with the chaos in the stock market. A particular field has both highly performing company and poorly performing company. Small and medium enterprises were analysed by applying Fuzzy AHP as a part of loaning evaluation



through weights and DEA is applied against overdue loaning [11]. In pharmaceutical field, poorly performing company has a more chance to develop by getting successful in their research works. And highly performing company has a chance to come down. Therefore there is a high possibility for a Pharma company to face both up movement and down movements alternatively. The investors try to invest in different companies within a same field. Also in stock market volatility and fluctuation is much higher and the volatility is examined using a random matrix approach and it is found that the Eigen Vector can be used to setup a Correlation Index which correlates with the volatility present in the market [19] while for fluctuations Multivariate Markov chain model is applied in order to predict the price change [18]. The Price volatilities in stock market is much higher and hence Markov process is applied with state dependency and the chains are found to be either aperiodic or ergodic [15]. Price fluctuations between Global financial indices and local indices were studied by using Random Matrix Theory. Eigen values were compared with the Eigen vectors after the crisis. The Inverse Participation Ratio was high after the crisis [21]. Therefore, after obtaining the results from AHP, the top three pharmaceutical companies were taken and their share holding pattern of their investors over a year is predicted with the help of Eigen Vector- Markov Chain. Russian stock market had a financial crisis during the year 2008 and Hidden Markov chain models were applied for analysing the structural changes in the Russian Stock markets [17]. A transition matrix was formed and the Eigen value was taken as 1. Markov Chain Monte Carlo algorithms were formulated for solving Eigen Value problems. Sufficient situation for building Robust and Interpolation Monte Carlo Algorithms were obtained as a result [20]. Markov Chain is applied in stock market to make predictions in three

states namely increase, decrease or remain unchanged. Transition matrix was derived and equilibrium was obtained after twenty years [16]. The condition for stable equilibrium which is $AV=V$ is achieved. For successful lead in investments focusing is also done on the technical analysis. Technical Total Risk Alpha, Treynor Ratio, Jensen Alpha, Mean Deviation, Potential Upside, Skewness, Information Ratio and SD-Standard Deviation were considered in analysis. Both the Results from Fundamental Part and Technical parts were focused and Artificial Intelligence was applied to select the best company to invest. Thus the investors are guided not only through the fundamental part but also guided with the technical aspects. AHP is also used in various applications like mobile services, Capital Budgeting Investment, Portfolio selection, Supplier selection. Identifying important mobile services for consumers is a herculean task and AHP is applied which indicated that the basic mobile communication services were the most preferred ones [14]. A decision making model is proposed in order to assist decision makers while performing capital budgeting investment. Goal Programming and Fuzzy Analytic Hierarchy Process forms the decision making model [13]. To solve the portfolio selection problem, Fuzzy is combined with Analytic Hierarchy Process thus providing both ranking and weighting information [9]. Supplier selection is one of the vital decision making problems which includes both qualitative and quantitative factors. Fuzzy AHP is used as a method for supplier selection in a washing machine company by defining main attributes and sub attributes [10]. In order to guide the investors in a right manner, the author's had deep view about the fundamental analysis of a firm by applying Fuzzy K-Means and K-Medoid algorithms to cluster the firms according to their performances [22].



Table-1.Literature comparison.

Authors	FAHP- VIKOR	AHP	FAHP	FAHP- DEA	AHP- SWOT	GP- FAHP	MC	GIBBS- MC	RM	MC- MCA
Rezaieet al [2014]	✓	×	×	×	×	×	×	×	×	×
Saatyet al [2007]	×	✓	×	×	×	×	×	×	×	×
Shayerdiet al [2014]	×	×	✓	×	×	×	×	×	×	×
Mani et al [2014]	×	✓	×	×	×	×	×	×	×	×
Badeaet al [2014]	×	✓	×	×	×	×	×	×	×	×
Calabreseet al [2013]	×	×	✓	×	×	×	×	×	×	×
Gaoet al [2012]	×	×	✓	×	×	×	×	×	×	×
Cakiret al [2008]	×	×	✓	×	×	×	×	×	×	×
Tiryakiet al [2009]	×	×	✓	×	×	×	×	×	×	×
Kilinciet al [2011]	×	×	✓	×	×	×	×	×	×	×
Cheet al [2010]	×	×	×	✓	×	×	×	×	×	×
Zaerpouret al [2008]	×	×	×	×	✓	×	×	×	×	×
Tang et al [2012]	×	×	×	×	×	✓	×	×	×	×
Nikouet al [2013]	×	✓	×	×	×	×	×	×	×	×
Okoeet al [2014]	×	×	×	×	×	×	✓	×	×	×
Chojiet al [2013]	×	×	×	×	×	×	✓	×	×	×
Bautinet al [2012]	×	×	×	×	×	×	✓	×	×	×
Maskawaet al [2004]	×	×	×	×	×	×	×	✓	×	×
Kulkamiet al [2007]	×	×	×	×	×	×	×	×	✓	×
Dimovet al [2008]	×	×	×	×	×	×	×	×	×	✓
Nobiet al [2013]	×	×	×	×	×	×	×	×	✓	×

Legend-1: FAHP-VIKOR- Fuzzy Analytic Hierarchy Process and VlseKriterijumskaOptimizacijaKompromisnoResenje, AHP-Analytic Hierarchy Process, FAHP- Fuzzy Analytic Hierarchy Process, DEA- Data Envelopment Analysis, SWOT- Strength, Weakness, Opportunities and Threats, GP-Goal Programming, MC-Markov Chain, RM-Random Matrix and MCA- Monte Carlo Algorithm.

Out of Twenty one Reference Papers, 4 papers are purely based on AHP concepts which rank the Criteria's and Alternatives with the help of Judgments and Pairwise Comparisons. 6 papers are based on the concept of AHP with Fuzzy and hence they are termed as FAHP. In FAHP membership function plays a vital role and weight ages are given in a different way. 3 papers deal with Markov Chain which gives accurate Prediction in

various applications like Evaluation of Performance in Computer, Web Search and Information Theory. 2 paper deals with Random Matrix Approach with the help of Eigen Vector are used to predict the volatility and fluctuations with the Correlation index. Rests of the papers are of Hybrid methodology based. They are FAHP- VIKOR, FAHP-DEA, AHP-SWOTGP-FAHP, GIBBS- MC, GP-FAHP and MC-MCA.



Table-2. Technical comparison.

Authors	FAHP-VIKOR	AHP	FAHP	FAHP-DEA	AHP-SWOT	GP-FAHP	MC	GIBBS-MC	RM	MC-MCA
Rezaieet al [2014]	Weighting criteria	x	x	x	x	x	x	x	x	x
Saatyet al [2007]	x	Handles Vibrant Decisions	x	x	x	x	x	x	x	x
Shayerdiet al [2014]	x	x	Accurate Decision	x	x	x	x	x	x	x
Mani et al [2014]	x	Helps in Supplier Selection	x	x	x	x	x	x	x	x
Badaeet al [2014]	x	Identifies Risk factors	x	x	x	x	x	x	x	x
Calabrese et al [2013]	x	x	Analyses IC Components	x	x	x	x	x	x	x
Gaoet al [2012]	x	x	Decision Support System	x	x	x	x	x	x	x
Cakiret al [2008]	x	x	Accurate Classification	x	x	x	x	x	x	x
Tiryakiet al [2009]	x	x	Ranking and Weight info	x	x	x	x	x	x	x
Kilinciet al [2011]	x	x	Supplier Selection	x	x	x	x	x	x	x
Cheet al [2010]	x	x	x	Identifies Overdue Loaning	x	x	x	x	x	x
Zaerpouret al [2008]	x	x	x	x	Accurate Classification	x	x	x	x	x
Tang et al [2012]	x	x	x	x	x	Decision making model	x	x	x	x
Nikouet al [2013]	x	Identifies Mobile Services	x	x	x	x	x	x	x	x
Okoeet al [2014]	x	x	x	x	x	x	Identifies Volatility	x	x	x
Chojiet al [2013]	x	x	x	x	x	x	Makes Predictions	x	x	x
Bautinet al [2012]	x	x	x	x	x	x	Identifies Structural Changes	x	x	x
Maskawaet al [2004]	x	x	x	x	x	x	x	Predicts Price changes	x	x
Kulkamiet al [2007]	x	x	x	x	x	x	x	x	Identifies Volatility	x
Dimovet al [2008]	x	x	x	x	x	x	x	x	x	Creates Sufficient situations
Nobiet al [2013]	x	x	x	x	x	x	x	x	Identifies Fluctuations	x

Table-2: Technical Comparison
Refer Legend-1

Literature Comparison is done for twenty one papers. AHP is used in various applications like making vibrant decisions, supplier selection in a washing machine company, identifying risk factors and identifying best mobile service provider. FAHP is used in a place where accurate clustering is required. It is also used in making a decision support system, supplier selection and in analysing IC Components. Markov Chain is used for prediction and they are used to find out the fluctuations

and volatility in markets. They are also used to find the structural changes in the market. Random Matrix theory is also employed to identify fluctuations and volatilities. Hybrid methodologies are used to provide weightage to the criteria and identify overdue of loaning in banks.

Architectural diagram for Stock Market Component analysis

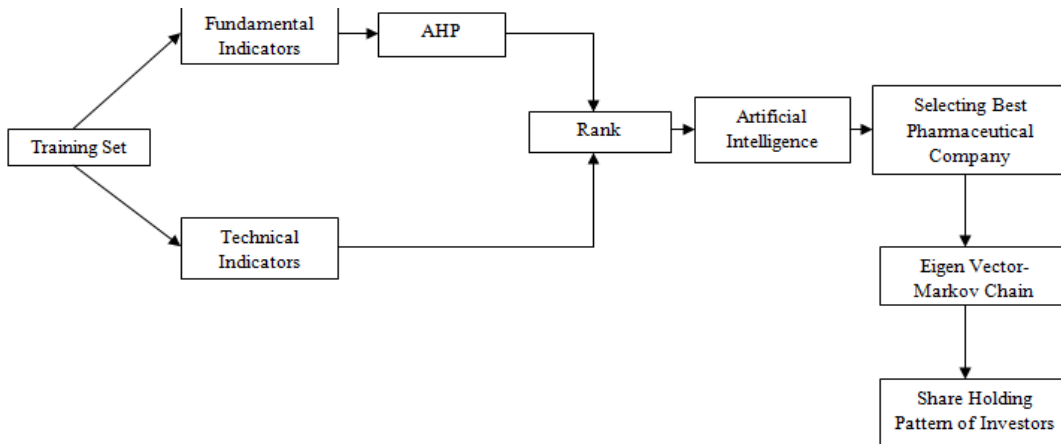


Figure-1. Architectural diagram for Stock Rate Component analysis.

Diagrammatic format for AHP

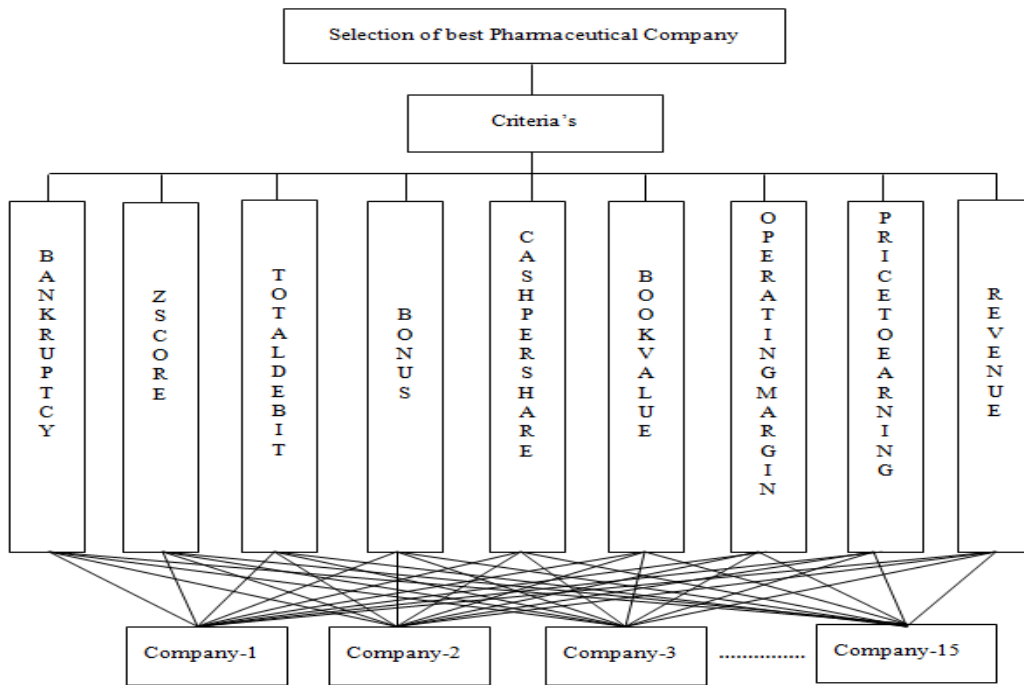


Figure-2. Diagrammatic format for AHP.

15 pharmaceutical companies have been taken for analysis and our aim is to rank these companies through AHP. In AHP the problems are rotten into a ladder of criteria and alternatives. Here the criteria's are Probability of Bankruptcy, Z-Score, Total Debit, Bonus, Cash per

Share, Book Value per Share, Operating Margin, Price to Earnings and Revenue. The alternatives are Glenmark, Cadila, Ranbaxy, Merck, Sun Pharma, Strides Arcolab, Cipla, FDC, Aurobindo, Torrent, Dr.Reddy's, Divi's Lab, Natco, Orchid and Pfizer.



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Table-3. Training Set.

Companies	PB	Z-Score	TD	Bonus	CPS	BVPS	OM	P/E	REVENUE
Glenmark	83.36	4.2	69.65	1	16.17	115.65	19.74	36.48	63.98
Cadila	94	8.4	77.63	2	22.55	191.18	15.18	35.33	79.78
Ranbaxy	64	2.4	39.97	6	49.03	86.26	12.63	447.96	110.03
Merck	84.4	3.6	72.14	2	5.03	15.81	22.38	33.16	43.08
SP	98	460.2	99.95	3	0.55	5.89	18.09	131.33	1.67
SA	56	1.2	84.06	0	28.02	170.14	13.27	2.75	10.06
Cipla	98	16.2	80.78	7	20.65	131.57	15	46.29	105.63
FDC	25	0	97.93	1	18.31	47.53	21.58	75	8.46
AP	70	3	63.66	2	6.13	128.67	22.65	17.57	80.38
Torrent	87	4.8	77.59	2	44.93	140.34	26.19	22.22	45.72
DR	96	9	61.15	4	168.68	581	19.21	26.35	140.38
DL	98	754.8	99.82	1	40.86	223.25	36.74	29.07	25.27
Natco	98	10.8	98.06	0	3.44	219.39	21.63	33.78	6.88
Orchid	25	0	79.95	1	25.35	80.23	12.57	5.3	18.74
Pfizer	72	3	62.88	4	5.31	12.37	31.77	19.59	50.04

Legend-2 (Row wise): PB-Probability of Bankruptcy, TD-Total Debit, CPS-Cash per Share, BVPS-Book Value per Share, OM-Operating Margin and P/E- Price to Earnings.

Legend-3 (Column wise): SP-SunPharma, SA-Strides Arcolab, AP-AurobindoPharma, DR-Dr.Reddy's and DL-Divi's Lab.

Probability of Bankruptcy = *Normalized Z-Score* (1)

$Z\text{-Score} = 1.2 * (\text{Working Capital} / \text{Total Assets}) + 1.4 * (\text{Retained Earnings} / \text{Total Assets}) + 3.3 * (\text{EBITDA} / \text{Total Assets}) + 0.6 * (\text{Market Value of Equity} / \text{Total Liabilities}) + 0.99 * (\text{Revenue} / \text{Total Assets})$ (2)

$TD = \text{Bonds} + \text{Notes}$ (3)

$CPS = \text{Total Cash} / \text{Average Shares}$ (4)

$BVPS = \text{Common Equity} / \text{Average Shares}$ (5)

$OM = (\text{Operating Income} / \text{Revenue}) * 100$ (6)

$P/E = \text{Market Value per Share} / \text{Earnings per Share}$ (7)

$\text{Revenue} = \text{Money Received} - \text{Discounts and Returns}$ (8)

One of the most important tasks is to rank the criteria before ranking the alternatives. The importance of each criterion may differ. So, it is necessary to rank the criteria's in order to know the best criteria. Judgments are much helpful in ranking the criteria's. Some of the Judgments are made. They are PB is 9 times as important as Revenue, Bonus is 2 times as important as CPS, Z-Score is 4 times as important as CPS and BVPS is 2 times as important as OM. Using pairwise comparisons the absolute weight of one criterion over another can be spoken. Thus a 9x9 pairwise matrix is formed and is listed below.

	PB	Z-Score	TD	Bonus	CPS	BVPS	OM	P/E	Revenue
PB	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1
Z-Score	1/2	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1
TD	1/3	1/2	1/1	2/1	3/1	4/1	5/1	6/1	7/1
Bonus	1/4	1/3	1/2	1/1	2/1	3/1	4/1	5/1	6/1
CPS	1/5	1/4	1/3	1/2	1/1	2/1	3/1	4/1	5/1
BVPS	1/6	1/5	1/4	1/3	1/2	1/1	2/1	3/1	4/1
OM	1/7	1/6	1/5	1/4	1/3	1/2	1/1	2/1	3/1
P/E	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1/1	2/1
Revenue	1/9	1/8	1/7	1/6	1/5	1/4	1/3	1/2	1/1

Refer Legend-2 (Row wise).

The fractions in the above matrix were reduced to decimals.



	PB	Z-Score	TD	Bonus	CPS	BVPS	OM	P/E	Revenue
PB	1	2	3	4	5	6	7	8	9
Z-Score	0.5	1	2	3	4	5	6	7	8
TD	0.33	0.5	1	2	3	4	5	6	7
Bonus	0.25	0.33	0.5	1	2	3	4	5	6
CPS	0.2	0.25	0.33	0.5	1	2	3	4	5
BVPS	0.17	0.2	0.25	0.33	0.5	1	2	3	4
OM	0.14	0.17	0.2	0.25	0.33	0.5	1	2	3
P/E	0.12	0.14	0.17	0.2	0.25	0.33	0.5	1	2
Revenue	0.11	0.12	0.14	0.17	0.2	0.25	0.33	0.5	1

Refer Legend-2 (Row wise).

Procedure to solve for the Eigen Vector:

- To obtain ranking of the alternatives, the Pairwise matrices which is in decimal form are squared every time.
- Row sum is calculated and Normalisation is done.
- This procedure is stopped when the difference between two consecutive steps are smaller.

By performing Squaring, Row sum and Normalisation for the first time we get Eigen Vector as

0.3096
0.2250
0.1588
0.1094
0.0740
0.0496
0.0334
0.0231
0.0171

By performing Squaring, Row sum and Normalisation for the second time we get Eigen Vector as

0.3126
0.2224
0.1553
0.1074
0.0738
0.0507
0.0350
0.0246
0.0182

The difference between two Eigen Vectors is relatively small. Therefore, the procedure is stopped and the second Eigen Vector is taken for Ranking.

Table-4. Result for ranking the criteria's.

Criteria	Eigen vector	Rank
PB	0.3126	1
Z-Score	0.2224	2
TD	0.1553	3
Bonus	0.1074	4
CPS	0.0738	5
BVPS	0.0507	6
OM	0.0350	7
P/E	0.0246	8
Revenue	0.0182	9

Refer Legend-2 (Row wise)

Pairwise comparisons are done for Criteria's in order to weight the Criteria. Now, it's time to Rank the Alternatives. Among 9 Criteria's, one Criteria termed Bonus is taken for solving it as an example. In terms of Bonus, a Pairwise comparison concludes the liking of each Alternative over another.

**Table-5.**Bonus details of 15 Pharmaceutical companies.

Companies	Glenmark	Cadila	Ranbaxy	Merck	SP	SA	Cipla	FDC	AP	Torrent	DR	DL	Natco	Orchid	Pfizer
Glenmark	1.00	0.50	0.17	0.50	0.33	0.00	0.14	1.00	0.50	0.50	0.25	1.00	0.00	1.00	0.25
Cadila	2.00	1.00	0.33	1.00	0.67	0.00	0.29	2.00	1.00	1.00	0.50	2.00	0.00	2.00	0.50
Ranbaxy	6.00	3.00	1.00	3.00	2.00	0.00	0.86	6.00	3.00	3.00	1.50	6.00	0.00	6.00	1.50
Merck	2.00	1.00	0.33	1.00	0.67	0.00	0.29	2.00	1.00	1.00	0.50	2.00	0.00	2.00	0.50
SP	3.00	1.50	0.50	1.50	1.00	0.00	0.43	3.00	1.50	1.50	0.75	3.00	0.00	3.00	0.75
SA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cipla	7.00	3.50	1.17	3.50	2.33	0.00	1.00	7.00	3.50	3.50	1.75	7.00	0.00	7.00	1.75
FDC	1.00	0.50	0.17	0.50	0.33	0.00	0.14	1.00	0.50	0.50	0.25	1.00	0.00	1.00	0.25
AP	2.00	1.00	0.33	1.00	0.67	0.00	0.29	2.00	1.00	1.00	0.50	2.00	0.00	2.00	0.50
Torrent	0.12	0.09	0.04	0.40	3.64	0.00	0.10	0.11	0.33	0.04	0.01	0.05	0.00	0.08	0.38
DR	4.00	2.00	0.67	2.00	1.33	0.00	0.57	4.00	2.00	2.00	1.00	4.00	0.00	4.00	1.00
DL	1.00	0.50	0.17	0.50	0.33	0.00	0.14	1.00	0.50	0.50	0.25	1.00	0.00	1.00	0.25
Natco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orchid	1.00	0.50	0.17	0.50	0.33	0.00	0.14	1.00	0.50	0.50	0.25	1.00	0.00	1.00	0.25
Pfizer	4.00	2.00	0.67	2.00	1.33	0.00	0.57	4.00	2.00	2.00	1.00	4.00	0.00	4.00	1.00

Refer Legend-3(Column wise)

Consider the Bonus column in the training set, now we have to make pair-wise comparisons of Glenmark along with the rest of other companies. The Bonus value of Glenmark is made to divide with the rest of the values of other companies in Bonus column. For example, on referring Glenmark with Glenmark we get $1/1$ which is 1. On making a pair-wise comparison between Glenmark and Cadila, we get $1/2$ which is 0.5 and on referring Glenmark with Ranbaxy we get $1/6$ which is 0.17. Same procedure is repeated while comparing each company with other companies. Then this Pairwise matrix has to be Squared,

Row sum is performed and Normalization is done to get an Eigen Vector. Then again the resultant matrix should be squared; Row summed and normalized to find the difference between the two Eigen Vectors. If the difference is negligible the process is stopped. Like Pairwise comparisons done for Bonus, the same procedure has to be repeated for PB, Z-Score, TD, CPS, BVPS, OM, P/E and Revenue. The final result is obtaining 15×9 matrixes which are shown below and 15 refer to the companies and 9 refer to the attributes considered for analysis.



Eigen Vector as a matrix for 9 Criteria's is shown below.

	PB	Z-Score	TD	Bonus	CPS	BVPS	OM	P/E	Revenue
Glenmark	0.0112	0.0072	0.0087	0.0069	0.0067	0.0076	0.0082	0.0086	0.0093
Cadila	0.0372	0.0303	0.0326	0.0321	0.0317	0.0331	0.0333	0.0339	0.0341
Ranbaxy	0.0698	0.0758	0.0734	0.0759	0.0747	0.0737	0.0730	0.0727	0.0723
Merck	0.0698	0.0758	0.0734	0.0759	0.0747	0.0737	0.0730	0.0727	0.0723
SP	0.0698	0.0758	0.0734	0.0759	0.0747	0.0737	0.0730	0.0727	0.0723
SA	0.0698	0.0758	0.0734	0.0578	0.0608	0.0624	0.0636	0.0645	0.0651
Cipla	0.0698	0.0758	0.0734	0.0759	0.0747	0.0737	0.0731	0.0727	0.0723
FDC	0.0699	0.0448	0.0547	0.0612	0.0634	0.0646	0.0654	0.0661	0.0665
AP	0.0724	0.0775	0.0756	0.0776	0.0764	0.0756	0.0755	0.0748	0.0747
Torrent	0.0752	0.0793	0.0776	0.0794	0.0786	0.0779	0.0774	0.0769	0.0767
DR	0.0752	0.0795	0.0777	0.0810	0.0798	0.0789	0.0783	0.0779	0.0776
DL	0.0752	0.0828	0.0798	0.0826	0.0811	0.0799	0.0791	0.0787	0.0782
Natco	0.0759	0.0832	0.0803	0.0632	0.0662	0.0681	0.0693	0.0702	0.0708
Orchid	0.0782	0.0502	0.0620	0.0686	0.0716	0.0732	0.0744	0.0746	0.0751
Pfizer	0.0806	0.0862	0.0839	0.0859	0.0849	0.0840	0.0834	0.0831	0.0828

Refer Legend-2(Row wise)

9 x 1 matrixes are listed below:

0.3126
0.2224
0.1553
0.1074
0.0738
0.0507
0.0350
0.0246
0.0182

This 15 x 9 matrix is multiplied with 9x 1 matrixes which are obtained by weighting the Criteria's. The resultant 15 x 1 matrix is shown below:

Table-6. Result for ranking the alternatives.

Rank	Companies	Eigen vector
1	Pfizer	0.0836
2	DL	0.0794
3	DR	0.0779
4	Torrent	0.0775
5	AP	0.0753
6	Natco	0.0753
7	Cipla	0.0731
8	Ranbaxy	0.0731
9	Merck	0.0731
10	SP	0.0731
11	SA	0.0689
12	Orchid	0.0674
13	FDC	0.0600
14	Cadila	0.0335
15	Glenmark	0.0087

Refer Legend-3(Column Wise)



Figure-3. Result of AHP for 15 Pharmaceutical companies.

Table-7. Technical details for the Pharmaceutical companies.

Companies	RAP	MRAP	VAR	MDD	TRA	TR	JA	MD	PU	SK	IR	SD
Glenmark	0.011	0.038	-2.61	8.16	0.292	0.028	0.018	1.4	2.56	-0.42	0.069	1.87
Cadila	0	-0.03	-2.23	5.54	0.214	-0.04	0.061	1.24	2.33	0.439	0.064	1.55
Ranbaxy	0.034	-0.4	-1.62	5.16	0.299	-0.41	0.033	1.09	3.54	0.02	0.106	1.63
Merck	0.182	-2.26	0	42.8	3.34	-2.27	1.83	3.71	0	4.69	0.226	9.12
SP	-0.17	0.916	-1.94	3.07	-0.06	0.906	-0.23	0.696	1.02	-0.63	-0.09	0.91
SA	0.272	-0.9	-3.04	17.6	1.9	-0.91	1.11	2.67	9.15	1.87	0.354	3.98
Cipla	0.157	-13.9	-1.92	5.5	0.752	-13.9	0.402	1.36	3.27	2.45	0.237	2.24
FDC	-0.01	-0.64	-2.49	8.67	0.291	-0.65	-0.04	1.7	2.43	0.944	0.034	2.21
AP	-0.07	0.444	-2.76	6.23	0.1	0.434	-0.23	1.38	2.82	0.368	-0.03	1.82
Torrent	-0.07	-0.48	-3.28	10.6	0.142	-0.49	-0.17	1.75	3.33	1.48	-0.04	2.44
DR	-0.16	-1.55	-2.43	8.77	-0.11	-1.56	-0.36	1.31	1.37	-1.6	-0.15	1.84
DL	-0.06	-0.93	-1.59	4.83	0.065	-0.94	-0.08	0.717	1.26	-0.39	0.031	1.03
Natco	-0.04	-1.79	-3.62	8.62	0.224	-1.8	-0.12	1.61	4	0.348	0	2.28
Orchid	0.072	0.311	-5.56	23.4	1.11	0.301	0.52	3.28	6.06	0.762	0.102	4.84
Pfizer	0.159	2.17	-1.43	9.64	0.755	2.16	0.434	1.32	3.15	2.99	0.24	2.23

Refer Legend-3(Column wise)

Legend-4: RAP-Risk Adjusted Performance, MRAP-Market Risk Adjusted Performance, VAR-Value at Risk, MDD-Maximum Drawdown, TRA-Total Risk Alpha, TR-Trey nor Ratio, JA-Jensen Alpha, MD- Mean Deviation, PU-Potential Upside, SK-Skewness, IR-Information Ratio and SD-Standard Deviation.

$$RAP = ((EROI-RFRR) * STD) / STD / RFRR \quad (9)$$

$$MRAP = EROI + ((1/BETA) - 1) * EROI - RFRR \quad (10)$$

$$VAR = EROI * N + (Z-SCORE * STD * SQRT(N)) \quad (11)$$

$$MDD = MAX(HIGH-LOW) \quad (12)$$

$$TRA = RFRR + ((EROM-EROI * STDI) / STD) \quad (13)$$

$$TR = (EROI - RFRR) / BETA \quad (14)$$

$$JA = (EROI - RFRR * (1 - BETA) - BETA * EROM) \quad (15)$$

$$MD = SUM(RDEV) / n \quad (16)$$

$$PU = 1PM / 2PM \quad (17)$$

$$SK = 3PM / STD^3 \quad (18)$$

$$IR = (EROI - EROM) / STD \quad (19)$$

$$STD = SQRT(V) \quad (20)$$

where RAP is Risk Adjusted Performance, MRAP is Market Risk Adjusted Performance, VAR is Value at Risk, MDD is Maximum Draw Down, TRA is Total Risk Alpha, TR is Trey nor Ratio, JA is Jensen Alpha, MD is Mean Deviation, PU is Potential Upside, SK



Stable Solution: $AV=V$, where V is an Eigen Vector with Eigen Value $\lambda = 1$, $AV=V$, $V(A-I) = 0$

$$\text{Null (A-I) = Null} \begin{bmatrix} -0.6 & 0.5 & 0.1 \\ 0.3 & -0.5 & 0 \\ 0.3 & 0 & -0.1 \end{bmatrix}$$

By applying the concept of Row Reduce we get the following matrix

$$= \text{Null} \begin{bmatrix} 3 & 0 & -1 \\ 0 & 5 & -1 \\ 0 & 0 & 0 \end{bmatrix}$$

Let $X_3=15$; $3 X_1-15=0$; $X_1=5$; $5X_2-15=0$; $X_2=3$

$$V = \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \\ 15 \end{bmatrix}$$

Verification for the Stable Solution $AV=V$

$$\begin{bmatrix} 0.4 & 0.5 & 0.1 \\ 0.3 & 0.5 & 0 \\ 0.3 & 0 & 0.9 \end{bmatrix} \begin{bmatrix} 5 \\ 3 \\ 15 \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \\ 15 \end{bmatrix}$$

Summing up all the column values of V , we get 23
 Pfizer= $5/23=21.74\%$, $DL = 3/ 23= 13.04\%$, and $DR= 15/23= 65.22\%$, where DL refers to Divi's Lab and DR refers to Dr.Reddy's.

Table-9. Investors share holding pattern within top three companies after a year.

Pharmaceutical companies	Share holding pattern inpercentage
Pfizer	21.74
DL	13.04
DR	65.22

The above table explains the share holding pattern of investors and they are said to be in Equilibrium. Even after a year goes by the share holding pattern of the investors will never change.

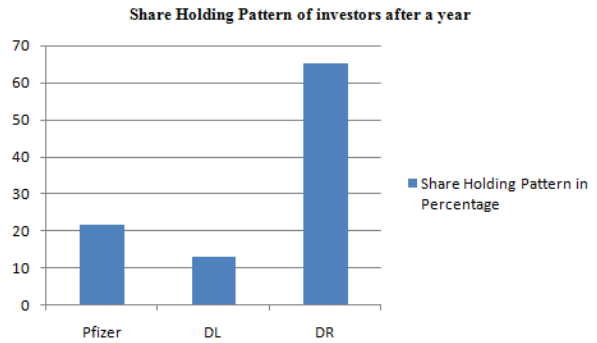


Figure-4. Share holding pattern of investors after a year.

RESULTS AND DISCUSSIONS

Pharmaceutical field has been selected for analysis and 15 companies from the same field were taken and with the help of Fundamental Analysis of the company, AHP algorithm was applied to rank these companies according to the weight-ages. But considering only the Fundamental Analysis will not be a good direction to travel and hence Technical Analysis of these pharmaceutical companies was taken and they were also ranked. By using Artificial Intelligence the investors can select the best pharmaceutical companies based on both the Fundamental and Technical parts. Investors change their investments when they obtain profit or loss from the respective firms. Investments by the investors change from time to time. So, there is a need to predict the investment pattern of the investors. With the help of Eigen Vector-Markov Chain application, the share holding pattern of the investors within the same field was analysed and its movement in terms with percentage was analysed and is valid when a year goes by.

CONCLUSIONS

A firm may be fundamentally weak, but it may be technically strong. Certain firms are weak in Technical's, but they are strong in Fundamental parts. In this paper weightage is given to both Fundamental and Technical parts. 9 Fundamental aspects and 12 Technical aspects will guide the investors in a right manner. Attributes like Probability of Bankruptcy which has been predicted as the best attribute will give details about bankruptcy of a firm for the next two years and it also gives a good idea about a firm for the investors. When the Criteria's are ranked Probability of Bankruptcy came under Rank1. AHP ranks both Criteria's and Alternative's. This indirectly suggest the best Alternatives to buy and also guides the investors to select best Criteria's in selecting a firm. From the result of AHP we can find the top three companies named Pfizer, Divi's Lab and Dr.Reddy's. With the help of Artificial



Intelligence we can conclude that Pfizer Company is best when focusing on both Fundamental and Technical aspects, thus giving a good path for the investors to invest their money.

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