Proposed System for Estimating Intrinsic Value of Stock Using Monte Carlo Simulation

Sehba Shahabuddin Siddiqui
M.E. Student
Department of Computer Engineering
St. Francis Institute of Technology
Mumbai-400103, India
sehbasiddiqui@outlook.com

Vandana A. Patil
Assistant Professor
Department of Information Technology
St. Francis Institute of Technology
Mumbai-400103, India
vandanapatil@sfitengg.org

***Abstract*— Stock market prediction has been the bane and goal for investors, and one of the biggest challenges for artificial intelligence (AI) community. National economies have a great impact by the behaviour of their stock markets. Markets have become a more accessible investment tool. Attribute that all stock markets have in common is uncertainty. This uncertainty associated with stock value in short and long term future investments are undesirable. Stock market prediction is instrumental in process of investment. Drawbacks of existing system faces technical difficulties such as estimating share of dividends, state vector while implementing stochastic modelling for risk analysis. To overcome drawbacks of existing system, proposed system makes an effort of generating a combination of more than one lakh seventy thousand scenarios to find intrinsic value of company, displaying results in graphical visualization. A large scenario generation of distinct intrinsic stock value done by the system will provide intrinsic stock value for each scenario. A large set of values for all the input parameters for example high growth value, declining growth value, terminal growth value, return on equity needs to be created, so that possible intrinsic value can be generated by system. The system will calculate statistical indicators like mean, median, mode, skewness and kurtosis of large data set consisting intrinsic value of company. Comparing statistically calculated intrinsic value and current market price, system will be able to add a robust statistical reasoning for investment decision. This reasoning will have no human or emotional biases as there will be no human intervention involved for arriving to the final intrinsic value of stock. Monte Carlo simulation is best suited solution for generating random scenarios that fall in line with Brownian walk motion of stock prices.**

Keywords*— current market price; graphical visualization; intrinsic value; monte carlo simulation; return on equity; statistical analysis; stock market

I. INTRODUCTION

An enterprise can be described with financial characteristics for example revenues, net profit, net working capital, depreciation, debt etc [1]. Prior making any decision it is necessary to estimate its impact on company's value [1] [2]. Globalization has been dominant theme for investors and businesses over last two decades. Investors invest in real assets which generate cash inflows and income. Evolving stock markets attract investors for several reasons; most evident is rapid economic growth. The captivation of emerging market could be strong as economic growth is related to strong earnings growth i.e. associated with higher stock returns for investors. The uncertain, volatile and probabilistic behaviour are indicators of the economy [14]. Capital markets provide buying and selling of equity and debt instruments. It is a means of saving as well as investment between purveyor of capitals, for example, retail and institutional investors, users of capital such as businesses, government and individuals. These markets are essential for the operation of an economy, as capital is a crucial element for producing economic output. Capital markets encompass primary markets, in which new stock and bond issues are vended to investors. Whereas secondary markets, comprises trade of current securities.

An investor allots capital with the presumption of a future financial return [3]. Various categories of investments include equity, debt securities, real estate, currency, and commodity, derivatives such as put and call options, etc [4][5]. There is no difference among those in primary and secondary markets. Investor tries finding out stocks that have a high potential to become a multibagger. These stocks multiply five times to ten times in a period of three to five years. Hence, investors have a time horizon of more than five years.

Existing system uses stochastic modelling for risk analysis and company development forecasting. Practical implementation faces technical difficulties due to uncertainty in financial characteristics. According to economics, there is always a demand and supply. Stock is made up of two values: (a) intrinsic value (b) market premium. According to analysts, if intrinsic value is ₹.100 but stock is trading at ₹.140 in market which means market is paying ₹.40 premium, due to demand and supply. Prediction of stock is done as investors are subjected to risk and they want to be aware about chances that their stock will give high returns i.e. stock will grow two, five or ten times maybe, and also to be aware of what will be the value of stock in various scenarios. Human beings can do fundamental analysis on excel sheet, but cannot create more than fifty scenarios. Also, there is a probability of making errors while creating scenarios for example typing errors. Even if scenario is created it is impossible to audit the scenario. Hence, we need a system to efficiently generate one lakh seventy thousand scenarios and save approximately five lakhs forty thousand man hours on every company's stock value analysed. If a stock is identified having an intrinsic value i.e. ₹.300 and market value of ₹.200, then the identified

stock has a potential of becoming worth more than ₹.300 in very near future of six to twelve months. The proposed system provides intrinsic value calculated after generating more than one lakh seventy thousand scenarios, and automatically suggests its user a recommendation whether to invest in stock or not. Artificial intelligence data visualization capability is not provided by any software system yet, and is also not available for individual or retail investor.

II. LITERATURE SURVEY

According to Ian Leifer et.al [1], after set up of simulation model, principal sources of uncertainty in cash flows is to be analyzed and then reduce the uncertainty by improving forecast of sales or costs. Author demonstrates how changes in model parameters influence cash flows. Valuation of business is done by several methods employed for cash flow forecasting. The methods can be separated into three main categories [1]:

- Heuristic Methods.
- Methods based on illustration of past data and trend detection using regression model, auto regressive models and learning models.
- Methods based on creation of imitational model, describing company parameters interconnection.

Stochastic model is used for analyzing risk and forecasting company's development that meets no primary difficulty. Meanwhile, practical implementation has number of technical difficulties connected with formularization of the problem [1]. Author further suggests how a company can be described as a set of financial characteristics, for example revenues, net profit, net working capital, depreciation, debt etc. in which state vector whose components are net profit, fixed assets, net working capital etc. can be described using finite-difference equation as given below:

$$A_t = F(A_{t-1}) \quad (1)$$

Equation (1) helps to find state at moment "t", if the state in moment "t-1" is given (state vector value in year "t" determines the state vector value in year "t + 1", value at year "t + 1" determines value at year "t + 2"and so on). It is significant to differentiate parameters that can be changed by manager (policy of company) and parameters that are independent (market price) and financial parameters are determined from company's financial statements [1]. Thus, the best managerial solutions are derived by running mathematical model. Utilization of stochastic modeling allows realizing the concept of value based management. Control parameters are key value drivers.

According to Manasi Shah et.al [6], artificial neural networks (ANN) used for stock prediction provides better results compared to other techniques. Artificial neural network is implemented as an efficient data mining technique in the field of finance trying to emulate human behavioural pattern for stock market investment [19]. Distinct architectures of ANN, simple feed forward back propagation neural network (FFBPNN), elman recurrent network, radial basis function network (RBFNN) are implemented and tested to predict stock price [12]. Sneha Soni [7] has done a survey of current literature in the domain of machine learning techniques and algorithms [17], artificial intelligence is used to forecast stock market movements. Artificial neural networks are ascendant machine learning technique in stock market prediction area [7]. Support vector machine and neural networks techniques are methods used for stock market prediction [6] [17]. Artificial neural networks can be applied for financial prediction in one of the three ways [7] [13]:

- Inputs are fed, that enables ANN to discover rules relating current state of the system being predicted to future states.
- There are window of inputs describing a fixed set of recent past states and relate those to future states.
- It could be designed with an internal state enabling it to study the association of an indefinitely large set of past inputs to future states.

Neural networks could solve any machine learning problems using two vital techniques: (a) fundamental analysis [16] and (b) technical analysis [18]. Although neural networks do not have any proven track records of success for certain specific problem domains, as a user of machine learning technology humans are better in using approaches that have stronger theoretical reason as follows [8].

- Neural Networks are too much of black box: It becomes difficult to train as training outcomes can be non-deterministic and depends crucially on the choice of initial parameters. It is hard to determine how problem is being solved as they are opaque.
- Neural Networks are not probabilistic: A neural network might give you a continuous number as its output, but translating that into problem statement is often difficult.
- Neural Networks are not suitable for understanding problems deeply.
- Artificial neural network is only useful for numerical inputs, vectors with constant number of values and data set with non-missing data.
- As artificial neural networks are data-driven control procedure, it cannot be used for sensitive or risky applications where trial error cannot be done when investing in a company or evaluating intrinsic value of company.

Mr. James D. Whiteside II [9] demonstrates empirical implementation of the Brownian-walk Monte Carlo simulation in forecasting. Simple spreadsheet and time-dependent historical data is used in forecasting. Historical data cannot be modelled using standard data regression techniques. It outlines a more robust methodology (no human intervention and works on random data sets) i.e. Monte Carlo simulation. Monte Carlo is efficiently used in data extrapolation (process of estimating beyond original observation in statistics), or forecasting that exceeds the known data points and interpreting the range of outcomes expected [9]. Model used for forecasts are not statements of what will happen, but what might happen given a specific data, presumptions, and analytical methodologies

used. They are notion of market, regulatory activities, and producer and consumer behaviour. Trends illustrated in forecasts are indicative tendencies in real world rather than representations of specific real-world outcomes. Monte Carlo simulation is a practiced mathematical technique for analysis of uncertain scenarios and providing probabilistic analysis of different situations [10]. Monte Carlo simulation is specifically used for probability based application that is an equation where variables have been replaced with a random number generator. A Monte Carlo simulation is a method for iteratively evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple of uncertain parameters. The basic need for using Monte Carlo analysis is, it is simple and easy to grasp [9] [10]. First, audience of who can describe a system that uses a set of basic math components, not understanding how all the individual elements can provide solution points to develop market insights [9]. Second, computers make approximations faster than working out a complex math solution, which still needs sophisticated and time-consuming computer programming in order to run multiple case studies [9]. Monte Carlo Simulations can be performed using add-ins (software that can be added to a computer to give extra features or functions) to microsoft excel [10].

The downside of Monte Carlo is that it does not trust historical trends rather, future data sets is taken into consideration based on random scenario generation [11]. If there is no historical data, then Monte Carlo forecast can be anything that is believed reasonable. Before endeavouring into applying Monte Carlo for calculating probabilities, program users should be able to validate a known value with some degree of precision. Otherwise, they will not be able to recognise when the application is correct, when to apply it, or if the result is realistic, approximated and quickly validated.

III. PROPOSED SYSTEM

Based on drawbacks of existing system identified in literature survey, system makes an effort of generating a combination of more than one lakh seventy thousand scenarios to find intrinsic value of a stock, results of which is displayed using graphical visualization. System performs statistical analysis on large data set of intrinsic values for every share. Comparing this statistically calculated value and current market price investor will be able to add a solid statistical reasoning for investment decision. This reasoning will not have human or emotional biases as there will be no human intervention involved in arriving to the final value.

In Fig.1, represents a block diagram of proposed system that briefly explains the process flow of the system. The system's primary requirement is to get financial data of last five years that includes profit loss statement and balance sheet of the company to be evaluated [15]. This historical data is given to Monte Carlo simulation block where the entire evaluation process takes place. In Monte Carlo simulation block, there is a combination of various vectors taken as input, for example growth rate, high growth years, cost of equity, beta (β) index sensitivity to nifty 50, reinvestment ratio. Then computational analysis is done on input vector using discounted cash flow (DCF), along with high growth period and declining growth period using two input vectors that are growth rate and ROE generated. Terminal growth rate value calculates terminal values using input vector return on equity, earning before income and taxes, free cash flow to equity, using gordon growth model. Thus, intrinsic value is calculated per share and statistical analysis is performed and output is generated in form if graphs and charts.

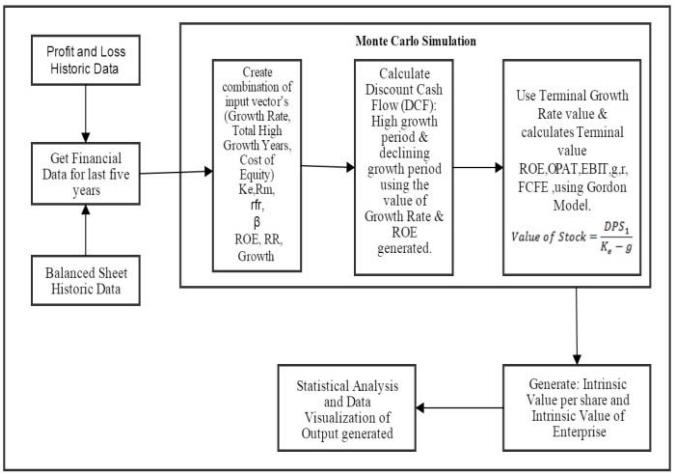

Fig. 1. Block diagram of proposed system.

The component of proposed system includes:

a) Input Data:

Historical data like profit and loss, balance sheet, income statement of any company can be taken from www.moneycontrol.com. According to securities exchange board of India (SEBI), all the companies are required to provide their financial statements, historical data free to the public hence getting historical data does not incur cost. Thus, system imports the data required for stock evaluation process.

- Import 5-year historical record of profit and loss statement and balance sheet.
- Identify the historical growth rate in revenue, operational profit, earnings per share and profit after tax.
- Input the expected high growth rate that will be used as a base.
- Input the expected high growth period.
- Input the current return on equity.
- Input the current total equity.
- Input the begning and ending year of valuation.

- Input expected terminal return on equity & terminal growth rate.
- Input the current total liabilities.
- Input the excess cash that company may have.
- Input the total value of non-cash investments made by the company.

c) Monte Carlo Simulation and Evaluation:

Step 1: Create value range for cost of equity (K_e).

$$K_e = rfr + (R_m - R_{Rfr})*\beta \quad (2)$$

In (2), rfr is risk free rate for ten years government bond yiled. R_m is return on market i.e. Nifty 50 is benchmark of India stock price.

Step 2: Calculate cash profit after tax (CPAT).

CPAT = (+) Depreciation (-) CAPEX (3)

In (3), (+) refers to adding of depreciaition i.e. non-cash expenses and (-) refers to subtraction of capital expenditure from company income statement.

Step 3: Calculate the value of earning per share (EPS).

EPS = profit after tax / number of shares (4)

In (3), earning per share is calculated by dividing amount after tax i.e. CPAT in previous step divided by total number of shares of a company.

Step 4: Create value range for return on equity (ROE).

ROE = PAT/ (total share capital + reserves surplus) (5)

In (4), the return that the company or stock will give to its shareholder is calculated. This is one of the most important matrix for a long term investor.

Step 5: Create value range for growth years.

Step 6: Create range for terminal growth.

Step 7: Create range for terminal return on equity.

Step 8: Select value for K_e from given range.

Step 9: Select value of high growth from given range.

Step 10: Select value of return on equity from given range.

Step 11: Select value of terminal growth from given range.

Step 12: Select value of terminal return on equity from given range.

Step 13: Calculate operating profit after tax (OPAT) and growth rate (g).

OPAT = EBIT*(1-t) (6)

In (5), net operating profit after tax is the net profitless taxes and finance cost that the business generates due to its normal operations. It excludes the returns it may receive due to extraordinary income arising from various activities like sale of assets etc. It also excludes returns from small minority investments.

Step 14: Calculate free cash flow to equity share holders (Free Cash Flow To Equity share holders).

$$FCFE_{total} = \sum_{i=1}^{n} \frac{FCFE_i}{(1+K_e)^i} \quad (7)$$

In (7), the present value of all the future estimates of cash flows for the share holder the stock is expected to generate over the time period for which the shareholder wishes to remain invested is calculated.

Step 15: Calculate present value of Free Cash Flow to Equity Share holders.

Step 16: Calculate intrinsic value by summation of free cash flow to equity share holders.

Step 17: Repeat step 7 to 13 until all combinations tested.

Step 18: Evaluate mean, median, mode, kurtosis, and standard deviation of prices.

Step 19: Generate pareto analysis diagram and graph.

Step 20: Generate price probability estimation graph.

d) Reports:

Based on given scenario, a data grid of all permutations and combinations will be generated with detail of outcome of each permutation that is scenario will be presented in row format. This grid can be exported in form of excel sheets and carry out financial analysis. The software will generate report on statistical evaluators like mean, median, mode, kurtosis and standard deviation. Software will also generate a graphical report showing paretto analysis graph which will display all of the possible scenarios generated. It will also generate probability pie chart showing five times, ten times and twenty times price valuation identifying the probability of scrip to become five, ten and twenty times of its current market price.

e) Performance analysis:

Many brokerage firms come up with stock ideas, which are investment ideas that can help investors multiply their wealth like ten or twenty times in a small period of five years. The number of such stocks are around fifty to sixty every year. Using this software top twenty stocks can be identified and then performance of those stocks can be evaluated every quarter by considering quarterly result and the new data. Over the period of one year this software can keep giving investors solid advice in terms whether they should remain invested or not. It can be evaluated that how many of the top twenty stocks selected by this software, multiplies the investors wealth by more than two times.

The parameters that define the performance of system are:

- Strike rate in (8) i.e. out of stocks suggested by the system how many gave a positive return.

$$\text{Strike Rate} = \frac{\text{No. of stocks} > 30\% \text{ return}}{\text{Selected stocks}} * 100 \quad (8)$$

- Cumulative returns obtained by investing in stocks that are suggested by the system.

For example, an investor has invested ₹.1000 each in every thrity stocks indicated by the system, so investor has made a total investment of ₹.30,000. Thus, how much did investor make by investing money equally in those thrity stocks. Above two parameters will help to evaluate performance of the system compared to existing system, because at the end of the day, for any investor most important thing is how much money did investor make by relying on artificial intelligence.

f) Example of performance analysis of proposed system:

The proposed system is designed to produce results which will be based on millions of scenarios, in order to guide the investor in doing relative comparison between the stocks that investor wants to compare with. Porposed system will produce statistical analysis which will act as a guideline for the comparison that will be made based on the current market price.

By randomly changing the vectors like high growth years, terminal growth rate, terminal ROE such that they cover ninty five percent confidence, stock price share is calculated. Current market price (CMP) is subtracted from this simulated price to get the price delta. Delta will be positive or negative as current market price may be more or less than the simulated price. The positive delta is what investor is interested in analysing, as the positive delta signifies that CMP is below the potential price that stock can achieve. The system will generate a factor, i.e nothing but a value that tells the user of system by how many times CMP has positive delta value for the stock. For example, if CMP of stock is ₹.100 and value per share obtained by a certain scenario generated by simulation is ₹. 250, the delta is ₹.150.

Now the delta factor is 2.5 as the delta is 2.5 times CMP. Higher the delta factor value greater is the probability of a stock to generate multiple returns. Also, proposed system will show how many scenarios yielded factors is greater than two, five, ten and hundred times of CMP out of all values generated. This will give probabilistic estimate from the simulated sample space of the possible probability of stock being a multi bagger. The two companies like 8K Miles Software Services & 3M India are to be studied as a sample and following analysis is to be given by the proposed Monte Carlo simulation analysis system.

Statitical analysis 8K Miles Software Services	
Mean	10,788.44
Standard Error	38.02
Median	6,138.39
Mode	140.94
Standard Deviation	14,104.52
Sample Variance	19,89,37,418.77
Kurtosis	16.83
Skewness	3.49
Range	1,48,470.40
Minimum	0.28
Maximum	1,48,470.68
Sum	1,48,50,39,243.22
Count	1,37,651.00

(a)

Statistical analysis 3M India	
Mean	13,197.86
Standard Error	82.96
Median	5,816.26
Mode	547.39
Standard Deviation	32,667.57
Sample Variance	1,06,71,70,451.49
Kurtosis	73.47
Skewness	7.73
Range	5,20,086.49
Minimum	0.60
Maximum	5,20,087.09
Sum	2046248445
Count	1,55,044.00

(b)

Fig. 2. Descriptive statistical analysis of (a) 8K Miles Software Services company with CMP ₹.620 3M India company ₹.12,000.

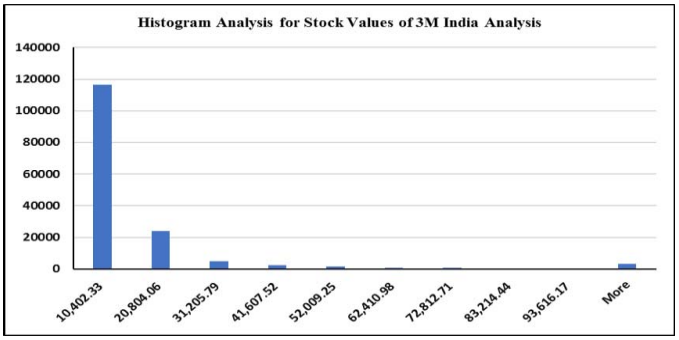

Fig. 3. Historgram analysis for stock value of 3M India company.

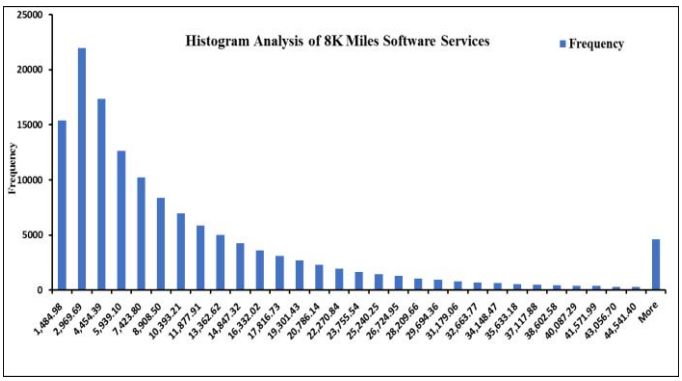

Fig. 4. Historgram analysis for stock value of 8K Miles Software Services company.

Comparing Figs. 3 and 4, it is observed that 8K Miles Software Services has much more fatter tail in terms of price dispersion as compared to 3M India. The skewness is positive with a very fat positive tail, thus a very strong positive skewness is illustrated in 8K Miles Software Services.

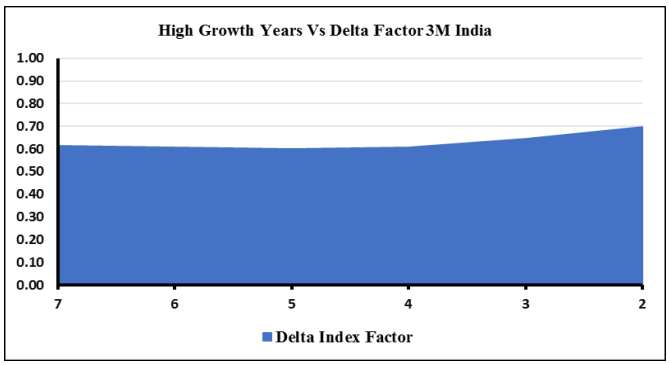

Fig. 5. High growth years compared to delta factor of 3M India company.

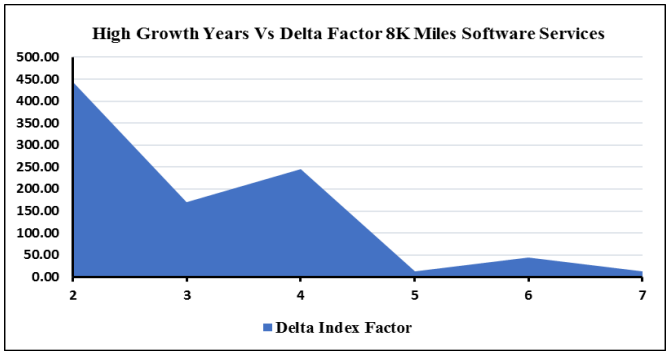

Fig. 6. High growth years compared to delta factor of 8K Mies Software Services company.

In Figs.5 and 6, it is evident that very high delta factors are present for 8K Miles Software Services as compared to 3M India even for low growth rate generated. This output from proposed system gives a clear indication of which stock has a great potential to be multi bagger, in this case it is 8K Miles Software Services.

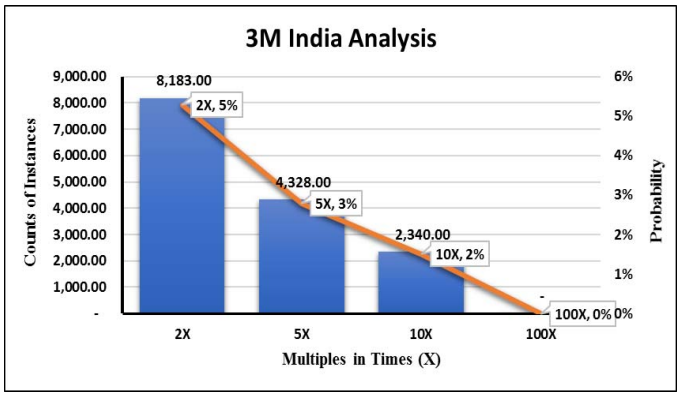

Fig. 7. Analysis of scenarios for 3M India company having high positive delta factor.

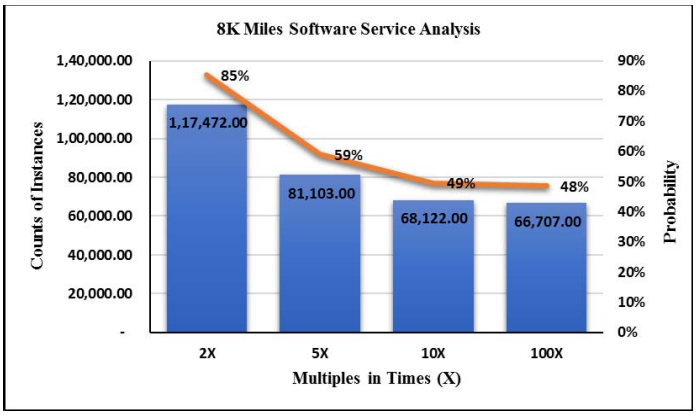

Fig. 8. Analysis of scenarios for 8K Miles Software Services having high positive delta factor.

In Figs. 7 and 8, illustrates the count of various scenarios showing simulated price higher than CMP and the factor by which the delta of simulated price to CMP is greater than CMP. In Figs. 7 and 8, bar graph generated by system has the count values whereas the line graph has the percentage of those counts of the total count. Comparing the results in graph 8K Miles Software Services has shown better results than 3M India. Thus, this graph which will be generated by system will give another important insight for investment.

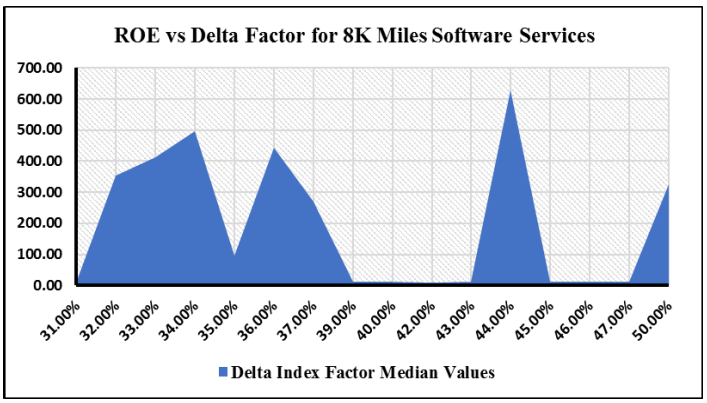

Fig. 9. Dependency of stock price and high delta factor on return on equity.

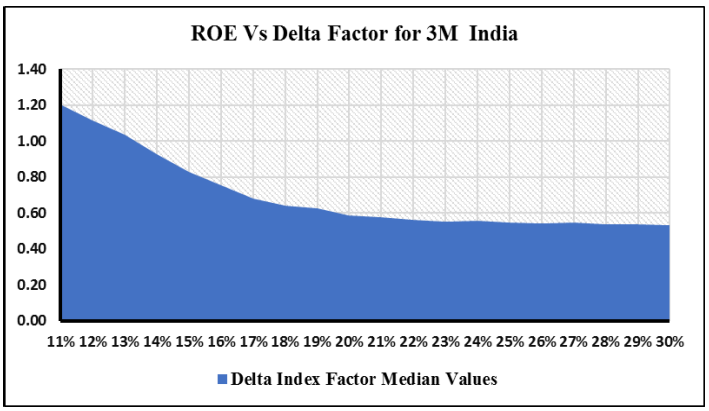

Fig. 10. Dependency of stock price and high delta factor on return on equity.

In Figs. 9 and 10, generated by proposed system user will get information on the dependency of stock price and high delta factor on ROE. In Fig.8, 8K Miles Software Services demonstrates very strong results in terms of very high delta factor for high ROE whereas in Fig.7, for high ROE values 3M India shows very low delta factor.

Hence, output generated by the proposed system will give investor clear insight of impact on return on equity to the share, which was not considered earlier in existing system using artificial neural network for long term investments. Stocks with higher probability of multiplying invested money, i.e. high delta factor to give high return in long term investment. Proposed system, in this case has considered 8K Miles Software Services and 3M India price. Parameter i.e. return on equity to share price is considered for companies in long term investment that are multibaggers.

IV. CONCLUSION

If proposed system is used on regular basis, it will allow investors to calibrate and take an informed judgment about their past and prospective investments. This system can help anyone with basic knowledge about stock valuation to judge money multiplying stocks with relative ease and with higher probability prediction along with very high strike rate. For example: stocks of companies like PI Industries, 3M India, Delta Corp, and Andrew Yule and Company so on. Twenty companies can be evaluated in ten hours. Whereas doing the same activity with only manual labor over excel or any other spreadsheet would involve five lakhs forty thousand man hours of peak efficiency.

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