Combinatorial Impact of Technical Indicators on Price Prediction in Colombo Stock Market

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Combinatorial Impact of Technical Indicators on Price Prediction in Colombo Stock Market

A dissertation submitted for the Degree of Master of Science in Computer Science

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Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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This is to certify that this thesis is based on the work of ~~Mr.~~/Ms. W.P.A. Lavanya under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: Dr. H.A. Caldera

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Signature: Date:

Abstract

Predicting the price in a stock market is a challenging task in a financial time series. Most researchers have predicted the stock market by using individual technical indicators. Investors can make use of this technology to find hidden patterns from the historic data to help them in their investment decisions. Despite the technical indicators are well-founded on the theory that the historical data holds the essential memory for predicting the future direction, there are several drawbacks when considering individual indicators. This research investigates the combinatorial effect of various technical indicators to analyze and forecast the stock market. Eleven technical indicators are combined with diverse ways to predict if the day's closing price would increase or decrease by ignoring the combinations which give more difference between the closing price. The combination of the 14-days Standard Deviation, 20-days Chaikin Money Flow Indicator with the average of 14-days Simple Moving Average, 14-days Bollinger Band, 14-days Upper Band, 14-days Lower Band, Average Price, 14-days Exponential Moving Average is found to be best.

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Evaluation panel, for pointing out new directions to approach the problem and the for the honest comments and feedback given.

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As well as everyone who spent time to listen to my questions and helped me to complete this thesis.

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List of Abbreviations

CSE	Colombo Stock Exchange
CSBA	Colombo Share Brokers Association
ASPI	All Share Price Index
S&P SL20	S&P Sri Lanka 20 Index
CDS	Central Depository System
ATS	Automated Trading System
SIA	Securities Investment Account
EPS	Earnings Per Share
BV	Book Value
TI	Technical Indicators
MA	Moving Average
SMA	Simple Moving Average
EMA	Exponential Moving Average
MACD	Moving Average Convergence Divergence
Parabolic SAR	Parabolic Stop and Reverse
SO	Stochastic Oscillator
SMI	Stochastic Momentum Index
CCI	Commodity Channel Index
RSI	Relative Strength Index
AP	Average Price
Std	Standard Deviation
BB	Bollinger Band
UB	Upper Band
LB	Lower Band
BBW	Bollinger Band Width
CMF	Chaikin Money Flow
OBV	On-Balance Volume
PVT	Price Volume Trend
MFI	Money Flow Volume
ANN	Artificial Neural Network
GA	Generic Algorithms

Chapter 1.   Introduction

1.1.   Introduction

Colombo Stock Exchange [1], [2] is the main stock exchange in Sri Lanka. It is one of the exchanges in South Asia, providing a fully automates trading platform. The CSE has 298 companies representing 20 business sectors at mid of 2018 with a Market Capitalization of Rs. 2,944.6 Bn.

Share Trading in Sri Lanka was initiated in 1896 under Colombo Share Brokers Association. In 1804 CSBA was renamed as Colombo Brokers' Association. They started auctioning shares in open land. Later a competitor evolved, Stock Brokers Association and in 1985 Colombo Brokers & Stock Brokers merged and formed Colombo Securities Exchange. In 1985 established a formal stock exchange with the incorporation of the CSE, which took over the Stock Market from the Colombo Share Brokers Association. Currently, it has a membership of 15 institutions, all of which are licensed to operate as stockbrokers. The business was renamed as Colombo Stock Exchange in 1990. CSE introduced Central Depository System and clearing.

In 1995 CSE headquarters was opened at World Trade Center, Colombo. Milanka Price Index was introduced in 1999 and several branches across the county in Kandy, Jaffna, Negombo, Matara, Kurunegala, Anuradhapura, Ratnapura, and Ambalantota.

There are two indices in the CSE,

- The All Share Price Index
- The S&P Sri Lanka 20 Index

CSE operates Central Depository System and Automated Trading System.

To invest in Sri Lanka's Stock Market, investors must [1], [3],

- Open a Securities Investment Account with an authorized custodian bank
- Find a Stock Brokerage Company
- Open CDS Account

Data Mining, Artificial Neural Network, Regression Analysis, Fuzzy Logic, Genetic Algorithms are used to predict stock prices [4]. Various external factors [5] such as interest rates, exchange rates, industry-specific information such as government policies, the growth

rate of industrial production and consumer price, oil and commodity rate are effect to the stock price. Therefore, identifying the most efficient methods to predict stock prices is difficult.

Data mining can be well-defined as "making better use of data". Ideally, we would like to develop techniques for "making better use of any kind of data for any purpose" [6].

According to the literature review, there are several methods used to predict stock market behaviors and they are categorized into three main parts as, Fundamental Analysis [4] [5], Technical Analysis [5] and Technological Analysis [4]. Fundamental Analysis concerns the tenets of the company's foundation theory to the selection of individual stocks. This type of analysis is not possible to fit into the objectives of the proposed system. The reason for this is that the data it uses to determine the stock value does not change daily because it uses the intrinsic value of the asset. Therefore, fundamental analysis is helpful for predicting the market only on a long-term basis. The technological analysis is another method used in stock trading. In this method stock market predict moves into the technological realm. The technical analysis seeks to determine the future price of a stock based solely on the trends of the past stock prices. Past stock prices are analyzed using the tool called technical indicators and correlated charts. These charts can be used to discover numerous patterns in the stock trading process and predict future stock trading directions.

1.2. Statement of the Problem

Currently, investors in the stock market get their investment decisions by using the previous day or week stock price variation, through the stockbrokers, investor forums or companies' news sites. Stockbrokers have massive experience and continuing knowledge gained through directly connected with the stock trading process every day. But none of them were based on analyzing the past stock data and therefore the predictions were often found to be less accurate. Therefore, investors need a more accurate system to guide their transaction decision.

Most researchers predict stock price by using individual technical indicators. But identifying the most efficient methods to predict stock prices is difficult.

There are several drawbacks when considering individual indicators.
Moving Averages don't consider changes that may affect a security's future performance, such as new competitors, higher or lower demand for products in the industry and changes in the

managerial structure of the company.

Moving Average Convergence Divergence has settings that can be changed to give almost limitless numbers of variations which means results will always differ from person to person. Generally, the MACD works best when it is confirmed across several different timeframes such as the weekly chart.

On-Balance Volume does not generate absolute values. It is therefore difficult to use it objectively for historical data comparisons. And, it is difficult to determine what constitutes high or low volume activity for a given session.

Therefore, different individual methodologies give different drawbacks. Among those methodologies, identifying which is the best combination of technical indicators to predict stock prices is the main objective of this research.

1.3. Aims and Objectives

To identify the best combination of technical indicators to predict the stock market is the main aim of this research. Following are the objectives of this research.

- Collecting stock market historical data and select the company, duration, attributes of stock data which is used to carry on the research.
- Investigate methodologies that are used to price prediction in the stock market.
- Go through the individual technical indicators with the selected dataset.
- Identify how to combine technical indicators to obtain best price prediction.
- Go through those identified combinations with the dataset.
- Among those combination, identifying which is the best combination of technical indicators to predict stock prices is the main objective of the research.

1.4. Research Scope

Several methods have been used to predict stock market behaviors and they are categorized into three main parts as, fundamental analysis, technological analysis and technical analysis. However, this research will consider only the technical indicators which come under technical analysis.

Discovering the best combination of technical indicators to predict stock prices is a very wide scope. Technical indicators, market-specific domain knowledge, various fundamental parameters such as political and economic factors can be considered as input variables to predict price in a stock market. This research, limits its scope to consider only the technical indicators as input variables.

1.5. Structure of the Thesis

Chapter 2 consists of Literature Review on the several methods used to predict stock market behaviors such as fundamental analysis, technological analysis and technical analysis. Under technical analysis describes market types, charts, and technical indicator and among those technical indicators how they categorized and what are the types of them will describe under this chapter.

Chapter 3 will explain Methodologies used in the research. It describes the research design, data selection and analysis of technical indicators which are used in this research. Proposed research used eleven technical indicators. They are Simple Moving Average, Exponential Moving Average, Moving Average Convergence Divergence, Relative Strength Index, Average Price, Standard Deviation, Bollinger Band, Upper Band, Lower Band, Bollinger Band Width and Chaikin Money Flow will describe under this chapter.

Chapter 4 provides the proposed solution of this research which is combination of technical indicators to predict stock price by analyzing the results of individual and combination of technical indicators by using the selected dataset.

Chapter 5 provides the evaluation of the results obtained from the graphical view of the individual and combination of technical indicators. By using these graphical views get the best combination of technical indicators to predict the stock price.

Chapter 6 provides the conclusion of the Thesis and the future work.

Chapter 2. Literature Review

2.1. Introduction

Data mining can be well-defined as "making better use of data". Ideally, we would like to develop techniques for "making better use of any kind of data for any purpose" [6].

Data mining [7] is powerful technology which helps to market companies to predict future trends and behaviors by extraction of hidden predictive information from large databases.

Data mining process [7], [8], [9] consists of,

- Selection – Collect data and select target data.
- Pre-processing – Pre-processing target data by using reduction, cleaning, and integration and get pre-processed data.
- Transformation – Transformation pre-processed data by using normalization, generalization, and aggregation, and get transformed data.
- Data mining – From transformed data identifying patterns by using data mining methods.
- Analysis – By analyzing patterns get the knowledge and predict future behaviors

In this chapter describes the several methods used to predict stock market behaviors such as fundamental analysis, technological analysis and technical analysis. Under technical analysis describes market types, charts, technical indicators and among those technical indicators how they categorized and what are the types of them will describe under this chapter.

2.2. Analysis of the Stock Market

According to the literature review, there are several methods used to predict stock market behaviors and they are categorized into three main parts as, fundamental analysis, technological analysis and technical analysis.

2.2.1. Fundamental Analysis

Fundamental Analysis [4], [5] seeks to forecast stock price on the basis of economic, industry and company statistics. Then they judge the prices of securities. Thus, fundamental analysts are making decisions based on their own options. In fundamental analysis, there is no scope for finding out the past trend of share and also the variations in the price trend. It helps to identify undervalued or overvalued.

2.2.2. Technological Analysis

Technological analysis [4] is a very popular analysis used to predict stock price daily and it involves in Artificial Neural Network and Genetic Algorithms. An estimate of the mathematical function is the main purpose of ANN. It is improving rapidly and producing increasingly helpful data for management, experience has shown that technological forecasts are subject to four main shortcomings. They are unpredictable interactions, unprecedented demands, major discoveries and inadequate data. These should be borne in mind by all policy-making executives as well as by specialists in the fields.

2.2.3. Technical Analysis

Technical analysis [5] mainly focuses on internal market data. Technicians believe that past trend will be repeated again and the current movements can be used for studying the future trend by using the technical analysis. It used to identify patterns on stock prices with short-term, mid-term and long-term data to predict future stock price. Therefore, the view of the market is the most important factor in determining stock prices. It is useful in timing a buy or sells order. Market Types, Charts, and Technical Indicators are used as techniques in technical analysis.

Market Types

Stock price [10] is increasing with time series is known as the bullish market or bullish trend and stock price is decreasing with time series is known as the bearish market or bearish trend. To ranging market as bullish or bearish, the clear pattern must appear from time to time. If the market is changing without a clear pattern, there is no real trend and the price goes up and down.

Charts

Charts [10] are very important tools in manual prediction and for technical analysis. Several types of charts are line chart, bar chart, and candlestick are illustrated in Figure 2. 1, Figure 2. 2, Figure 2. 3 accordingly.

Candlestick chart is mostly used because it provides more details about the market compared to the line chart. This chart has time durations can be adjusted with the help of a trading platform according to the needs of the trader. The candlestick chart consists of a candle-like bar which reveals useful information to the traders. Candle charts are created according to the given time duration. The hallow candle expresses that the closing price is lower than the opening price for the given time.

Time to time these charts show different patterns such as ascending triangle, descending triangle, double bottom, double charts, head & shoulders, flags & pennants, etc.

Figure 2. 1: Line Chart

Figure 2. 2: Bar Chart
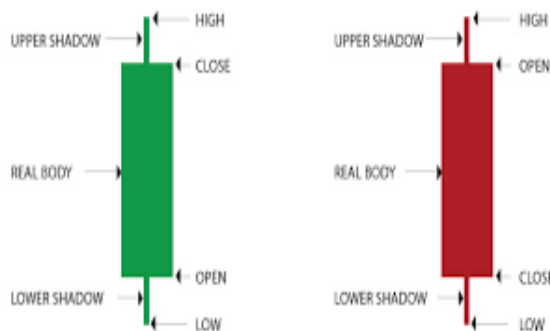
Figure 2. 3: Candle Stick Chart

Technical Indicators

One of the most accurate methodology to predict the stock price is technical indicators which come under technical analysis. Technical indicator [5], [11] is a mathematical calculation that can be applied to a stock's past patterns, like price, volume or even to another technical indicator. Technical Indicators do not analyze any part of the fundamental business, like profit margins and earnings revenue. Technical Indicators are most extensively used by active traders

in the market, as they are primarily designed for analyzing short-term price movements. Most technical indicators are little value to a long-term investor. The result is a value that is used to [11], [12]:

Accept: the trader about a trend

Predict: the direction of future prices

Confirm: technical analysis suggested by another indicator(s)

Categories of Technical Indicators

Technical Indicators are categorized into two main parts as, leading indicator and lagging indicator.

Leading Indicator

Leading Indicators [5], [11], [12] are considered to point toward future events. It gives us more opportunities to buy and sell. They signify a form of price momentum over a fixed look-back period, which is the number of periods used to calculate the indicator. Leading Indicators use a shorter period than the lagging indicators in the calculation.

Lagging Indicator

Lagging Indicators [5], [11], [12] do not consider pointing toward future events. They are seen as confirming a pattern that is in progress. Lagging Indicators tell us what prices are doing, whether they are increasing or decreasing, and we can invest accordingly. All the indicators are lagging indicators but some are call leading as they try to predict price by short period in calculation.

Types of Technical Indicators

Indicators from leading and lagging categories belong to one of the types. Types are trend indicator, momentum indicator, volatility indicator and volume indicator.

Trend Indicator

Trend Indicators [11] used to measure the strength of a trend, using some form price averaging to establish a baseline. If the price moves above the average, is known as the bullish trend and if the price moves below the average, is known as the bearish trend.

Momentum Indicator

Momentum Indicators [11], [12] used to identify the speed of price movement by comparing prices over time. Also, it can be used to analyze volume. It is calculated by comparing the current closing price to previous closing prices. Typically, this appears as a line below a price chart that oscillates as momentum changes. When there is a divergence between price and a momentum indicator, it can be a signal of change price in future.

Volatility Indicator

Volatility Indicators [11] used to measure the rate of price movement. This is generally based on the change in the highest and lowest historical prices. They provide useful information about the range of buying and selling that take place in the given market and help traders determine points where the market may change direction.

Volume Indicator

Volume Indicators [11] used to measure the strength of a trend or confirm a trading direction based on some form of averaging or smoothing of raw volume. The strongest trends often occur while volume increases; in fact, it is the increase in trading volume that can lead to large movements in price.

Table 2. 1 illustrates how technical indicators are mapping with categories and types.

Trend Indicators		
	Leading Indicator	**Lagging Indicator**
Moving Averages (SMA, EMA)		✅
Moving Average Convergence Divergence		✅
Parabolic Stop and Reverse	✅	
Momentum Indicators		
Relative Strength Index	✅	
Commodity Channel Index	✅	
Stochastic Oscillator	✅	
Williams %R	✅	
Stochastic Momentum Index	✅	
Volatility Indicators		

Standard Deviation		✅
Bollinger Bands (BB, LB, UB, BBW)		✅
Average Price		✅
Volume Indicators		
Volume Rate of Change		✅
Chainkin Oscillator	✅	
On-Balance Volume	✅	

Table 2. 1: Technical indicators mapping with categories and types

Moving Average

Moving Average [11] is a trend, lagging indicator which used to identify current trends, trend reversals and to set up support and resistance levels. In other words, MA [5], [6], [9] returns the moving average of a field over a given period. Most MAs based on closing price. The chart shows the average value over time. Simple Moving Average and Exponential Moving Average are used mostly.

Simple Moving Average

SMA [5], [9], [13], [14] is arithmetic moving average, calculated by adding the closing price of the security for several time periods and then dividing this total by the number of periods. Most stockbrokers are used SMA for 14 days and known as SMA14.

SMA = (sum (Closing Price, n)) /n

n= n-day Time period

Exponential Moving Average

EMA [5], [9], [15], [14] is similar SMA, except that more weight is given to the latest data. It's also known as the Exponential Weighted Moving Average. For recent price changes EMA, answers faster than the SMA. Most stockbrokers used EMA for a lengthy period to find the long-term behavior of the market. Most stockbrokers used EMA for 14 days and it called as EMA 14.

EMA = (P – EMAp) * K + EMAp

K = 2 / (n+1)

P – Current Closing Price

EMAp　–　Previous EMA

K = smoothing constant

n = number of periods

Moving Average Convergence Divergence

MACD [5], [8], [11], [16], [17] is a trend, leading indicator which used to reveal changes in the strength, direction, momentum, and duration of a trend in a stock's price. MACD is the difference between 12-day EMA (EMA12) and 26-day EMA (EMA26) of a stock price. This result is an indicator that moves above and below zero. MACD above zero imply EMA12 higher than EMA26 which is upward shift demand supply. If MACD below zero, it suggests a downward shift in demand-supply. 9-day EMA of the MACD is known as Single line. The first value of the single line is simply a 9-day trailing average and all other values are given by the below equation, where the time is 9.

MACD = FastMA – SlowMA

FastMA – Shorter MA

SlowMA – Longer MA

SignalLine = MovAvg(MACD)

MACD Histogram = MACD – SignalLine

e.g.: MACD = EMA12 - EMA26

Parabolic Stop and Reverse

Parabolic SAR [11], [18], [19] is a trend, leading indicator which used to find potential reversals in the market price direction.

Parabolic SAR = P + A(H-P)

Parabolic SAR – Long Stop and Reverse Price at which the position is reversed from Long to Short

P – Previous Parabolic SAR

A – Acceleration factor

H – Highest Price since the current long trade was opened on a buy stop order

Parabolic SAR = P - A(L-P)

S – Short Stop and Reverse Price at which the position is reversed from Short to Long

L – Lowest Price since the current short trade was opened on a sell stop order.

Stochastic Oscillator

SO [6], [9], [11], [10], [20] is a momentum, leading indicator which used to predict price turning points by comparing the closing price to its price range. It works exceptionally well in ranging markets showing what markets may be overbought or oversold with highlighting extreme movement in price. Stochastic indicator for 14 days is short-term trading and called as

Stochastic 14.80% range value of SO indicates overbought in ranging market and 20% indicates oversold in a ranging market. Rest indicates fail predictions.

%K = 100 (C-L14) / (H14 – L14)

C = Current Closing Price

L14 = Lowest Price of the 14 previous trading sessions

H14 = Highest Price of the 14 previous trading sessions

%K = Current market rate for the currency pair

%D = 3-period moving average of %K

Williams %R

Williams %R [21], [10], [22] is very similar to the SO and the only difference between the two indicators is how they're scaled. It also is known as the Williams Percent Range, is a type of momentum indicator that moves between 0 and -100 and 0 to -20 are considered as overbought and -80 to -100 are considered as oversold levels. The Williams %R is frequently used to find entry and exit points in the market.

%R = -100 * ((Highest High – Current Closing Price) / (Highest High – Lowest Low))

Highest High – Highest High in the past n periods

Lowest Low – Lowest Low in the past n periods

Stochastic Momentum Index

SMI [6], [23] is based on the SO. The difference is that the SO calculates where the close is relative to the high/low range, while the SMI calculates where the close is relative to the midpoint of the high/low range. The value of the SMI range from +100 to -100. When the close is greater than the midpoint, the SMI is above zero, when the close is less than the midpoint, the SMI is below zero. The SMI is interpreted the same way as SO. Extreme high/low SMI values indicate overbought/oversold conditions. A buy signal is generated when the SMI rises above -50, or when it crosses above the signal line. A sell signal is generated when SMI falls below +50, or when it crosses below the signal line. Also, look for deviation with the price to signal the end of a trend or indicate a false trend.

SMI = 100 * (DS2/DL2)

DS1 = 3*D*EMA

DS2 = 3*DS1*EMA

DL1 = (HighMax - LowMin) * 3 *EMA

DL2 = 3 * DL1 * EMA * ½

D = CCTODAY - C

C = (HighMax + LowMin) /2

CCTODAY = Current Closing price

HighMax = Highest high in the range

LowMin = Lowest low in the range

Commodity Channel Index

CCI [11], [24], [25] is a momentum, leading indicator. CCI is an oscillator used to identify price reversals, price extremes, and trend strength. CCI compares the average mean price over a typical window of 20 periods with the current mean.

CCI = (M – A)/ (0.015 * D)

M = (H+L+C) /3

D = M- A

H – Highest price of the period

L – Lowest price of the period

C – Closing price of the period

A – n period moving average of M

D – mean deviation of the absolute value of the difference between the mean price and the moving average of mean price

Relative Strength Index

RSI [6], [8], [11], [26], [27] is a momentum, leading indicator. RSI is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. It is expressed in values from 0 to 100. If RSI of the stock is above 70 then the stock is considered as overbought and if RSI is below 30 then the stock is considered as oversold. Usually, RSI of the stock is calculated for 14 days timeframe.

RSI = 100-(100/[1+RS])

RS = AG/AL

AG = [(PAG)*13+CG]/14

AL = [(PAL)*13+CL]/14

PAG = Total gain during the past 14 periods/14

PAL= Total losses during the past 14 periods/14

AG=Average Gain

AL= Average Loss

PAG = Previous Average Gain

PAL=Previous Average Loss

CG=Current Gain

CL = Current Loss

Average Price

Average price [6] only prepared on the author's sensitivity and doesn't see in any of the stock market text. It can be calculated using total turnover divided by the total number traded for the trading day. Average Price greater than benchmark we should sell or to buy.

AP = (H+L+C)/3

H=High value of the daily share

L = Low value of the daily share

C=Close value of the daily share

Standard Deviation

Std [9], [11], [28], [29] is volatility, a lagging indicator which used to measure expected risk and determine the significance of certain price movements. A quantity of significant importance in probability and statistics is called the variance.

$\sigma 2 = [\text{sum} (Pi - \mu)2] / n$

σ2 – Variance

σ - standard deviation = Positive square root of the variance

n - number of values

Pi = Each value of the sample

μ = mean of the values

Bollinger Band

Bollinger Band [5], [6], [8], [9], [11], [30], [31] is volatility, a lagging indicator which used to measure the "highness" or "lowness" of the price, relative to previous trades. Bollinger band is the most popular technical indicator which is consisted of Simple Moving Average, Upper Band, Lower Band, and Standard Deviation and used to determined volatility of the stock, to identify overbought and oversold. The author has customized this indicator to include dataset using MS Excel function. Market behave normally when the current price of the stock is within these BB otherwise market should do correct actions to get the price inside the bands.

n=n-day Time period

MiddleBand = MA = n-period of moving average = sum (ClosingPricei) / n

Upper Band

Upper Band [6], [8], [30], [31] is used to create BB and is not a professional indicator but can be used to identify up movements in markets. The upper band is two standard deviations above the moving average. As for price rise to the upper band, the stock becomes more overbought meaning price should fall. If the current price breaks through the upper band it is considered as a sell signal.

n=n-day Time period

D= Number of standard deviation

σ = standard deviation

UpperBand = MiddleBand + (D * n-period of standard deviation)

= MiddleBand + {D * sqrt (sum (ClosingPricei - MiddleBand)2 / n)}

= MiddleBand + D * σ

Lower Band

Lower Band [6], [8], [30], [31] is used to create BB and is not a professional indicator but can be used to identify down movements in markets. The lower band is two standard deviations below the moving average. As price moves closer to the lower band stronger the indication is that stock is oversold the price should rise soon. If the current price breaks through the lower band it is, consider a buy signal.

n=n-day Time period

D= Number of standard deviation

σ = standard deviation

LowerBand = MiddleBand - (D * n-period of standard deviation)

= MiddleBand - {D * sqrt (sum (ClosingPricei - MiddleBand)2/ n)}

= MiddleBand - D * σ

Bollinger Band Width

BBW [6], [32], [33], [34] is derived from Bollinger Bands and its measure width between upper and lower bands quantitatively. BBW can be used to identify trading signals in some occurrences. Both bullish and bearish BBW, BBW is dropped and volatility increases. But in bullish BBW price breaks through the upper band which starts a new upward trend and bearish BBW price falls below the lower band which starts a new downward trend.

Bollinger Band Width = (Upper Band – Lower Band) / Middle Band

Chaikin Oscillator

Chaikin Oscillator [11], [35], [36] is momentum, a leading indicator which monitors the flow of money in and out of the market-comparing money flow to price action helps to identify tops and bottoms in short and intermediate cycles. Like other momentum indicators, Chaikin Oscillator is designed to anticipate directional changes in the Accumulation Distribution Line by measuring the momentum behind the movements. The first step to a trend change is momentum change. Anticipating trend changes in the Accumulation Distribution Line can support chartists anticipate trend changes in the underlying security. The Chaikin Oscillator produces signals with crosses above/below the zero line or with bullish/bearish divergences.

Chaikin Oscillator = (3-day EMA of ADL) – (10-day EMA of ADL)

ADL = Previous ADL + Current Period's MFV

MFV= MFM * Volume of the period

Money Flow Multiplier = [(C– L) – (H – C)]/ (H – L)

MFV = Money Flow Volume

MFM - Money Flow Multiplier

C – Closing Price

H – High Price

L – Low Price

Chaikin Money Flow

CMF [6], [37] is based on Chaikin's accumulation/distribution. Accumulation/distribution, in turn, is based on the premise that if the stock closes above its midpoint [(high+low)/2] for the day, then there was accumulation that day, and if it closes below its midpoint, then there was the distribution that day. Chaikin's money flow is calculated by summing the values of accumulation/distribution for 13 periods and then dividing by the 13-period summation of the volume.

CMF = sum (AD, n)/sum (VOL, n)

AD = VOL{(CL-OP)/(HI-LO)}

AD - Accumulation Distribution, where n=Period

CL=today's closing price

OP=today's opening price

HI=High Value

LO=Low value

On-Balance Volume

OBV [8], [11], [38], [39] is a leading, momentum volume-based indicator which considers daily stocks volume in its construction. If the stock is closing positive, then the volume is added otherwise volume is subtracted. Thus, OBV keeps a running total of volume. OBV shows if the volume is flowing into or out of stock. If high volume flows into the stock with the same or high price indicate more demand for the stock.

$$OBV = \text{Cumulative} (\text{Volume}_{up} - \text{Volume}_{down})$$

Volume = Actual, Tick

Volume_{up} = Quantity of volume occurring on up price change

Volume_{down} = Quantity of volume occurring on down price change

Price Volume Trend

PVT [8], [40] relates to stock price with stock volume traded. PVT is calculated by multiplying the day's volume by the percent that the stock's price changed from the previous day close and adding this value to a cumulative total. PVT is more accurate compared to OBV as it indicates an accurate flow of money into the stock.

$$PVT = \{((\text{ClosingPrice} - \text{PreviousClosingPrice}) / \text{PreviousClosingPrice}) * \text{Volume}\} + \text{PreviousPVT}$$

Money Flow Volume

MFI [8] measures the strength of money flowing into the stock and money flowing out of stock. Thus, MFI confirms the reliability of current stock trend. MFI uses both volume and price to measure demand and supply or buying and selling pressure. MFI is negative when stock prices are down, and it is positive if stock prices are up.

MFI = 100 – (100/ (1+ Money Ratio))

Money Ratio = Sum of Positive Money Flow / Sum of Negative Money Flow Money

Flow = AP * Volume

AP = (H+L+C)/3

H=High value of the daily share

L = Low value of the daily share

C=Close value of the daily share

Volume Rate of Change

Volume Rate of Change [11], [41] is a volume, lagging indicator which highlights an increase in volume, which normally occurs significant market tops, bottoms, and breakouts. The volume rate of Change measures the percentage of current volume as compared to the volume a certain

number of period ago. The Volume Rate of Change indicator might be used to confirm price moves or detect deviations.

Volume Rate of Change = [(Current Volume / Volume n period ago) - 1] *100

Pivot Point

Pivot point [8] is considered a point of rotation. It is a crucial point indicating which way the market is heading during the day. Pivot point demonstrations critical support and resistance levels at which stock price can change. Pivot is calculated by the open, high, low and close price of the stock from the previous trading day.

Pivot = (H + L+ C) / 3

Support1 = (2 * P) – HighPrice

Resitance1 = (2*P) - LowPrice

Support2 = P - (R1+ S1)

Resistance2= P - (S1 + R1)

H – High Price

L – Low Price

2.3. Summary

In this chapter described on the several methods used to predict stock market behaviors such as fundamental analysis, technological analysis and technical analysis. Under technical analysis describes market types, charts, technical indicators and among those technical indicators how they categorized and what are the types of them were described under this chapter. Selected technical indicators will be used to identify which is the best combination of technical indicators to predict stock prices.

Chapter 3.   Methodology

3.1.   Introduction

As described in section 2.2.2 technical analysis used to identify patterns on stock prices to predict future stock price by constructing a variety of charts plotting stock price changes. Investors predict future stock price by using these charts. Technical analysts or chartists seek to determine the future price of a stock based only the potential trends of the past price and they do not concern with the fundamentals of the company. Techniques which are used in technical analysis are market types, charts, technical indicators described under the section 2.2.2.

Technical indicators reflect inside mirror image of stocks. Investors can understand the energetic secrets inside the market. Exit and Entry secrets are significant for successful investing. Exit technique is to sell a stock at the time when it seems the uptrend is over at least before a downtrend has progressed extraordinarily far and Entry techniques are to get a stock when it is getting ready to enter an uptrend and to avoid those stocks that are in a downtrend or a long basing pattern.

Stock trading is a process totally based on time. Therefore, data timing type stock trading indicators act a leading role to predict stock price. Timing type stock trading indicators can mainly be dividing into two main parts as leading indicators and lagging indicators which described under the section 2.2.2.

Leading indicators are better to predict future trend. It precedes price movements and is often used to generate buy and sell signals. Leading indicators are good, whether a stock price has gone too high up or too far down, and whether there is a slowdown in price movement. The stock price has gone too high up is known as overbought and the stock price has gone too far down is known as oversold. Leading indicators help investors to predict the behavior of the stock trading process and is unable to extract information about the trend pattern of the stocks. Therefore, these types of indicators only provide the warning signal, but it is unable to confirm it really happen or not.

Lagging indicators are following the stock price pattern. Therefore, they deal with the past stock data and they are good in showing whether a trend is developing or whether at stock is in a trading range. (i.e. trading sideways). Lagging indicators are not good in predicting future but they can show what trends have developed until the current point. These lessons are more

reliable than the leading technical indicators. However, they have another problem; in many cases, a trade could be opened and closed when it is too late because it does not provide any warning signals at the beginning. Therefore, investors may react at the trend already in reversal movement.

Therefore, using leading or lagging indicators individually does not lead a better trading decision. But the combination of leading and lagging indicators allows significantly increase the effectiveness of a trading system. The leading indicators could be used to generate a signal and alert a trader about possible reversal. Then lagging indicators could be used to confirm this reversal and open or close a trade. So proposed research was able to accurately guide the investors for their transition decision.

In this chapter describes the research design, data selection and analysis of technical indicators which are used in this research. Proposed research used eleven technical indicators. They are Simple Moving Average, Exponential Moving Average, Moving Average Convergence Divergence, Relative Strength Index, Average Price, Standard Deviation, Bollinger Band, Upper Band, Lower Band, Bollinger Band Width and Chaikin Money Flow.

3.2. Research Design
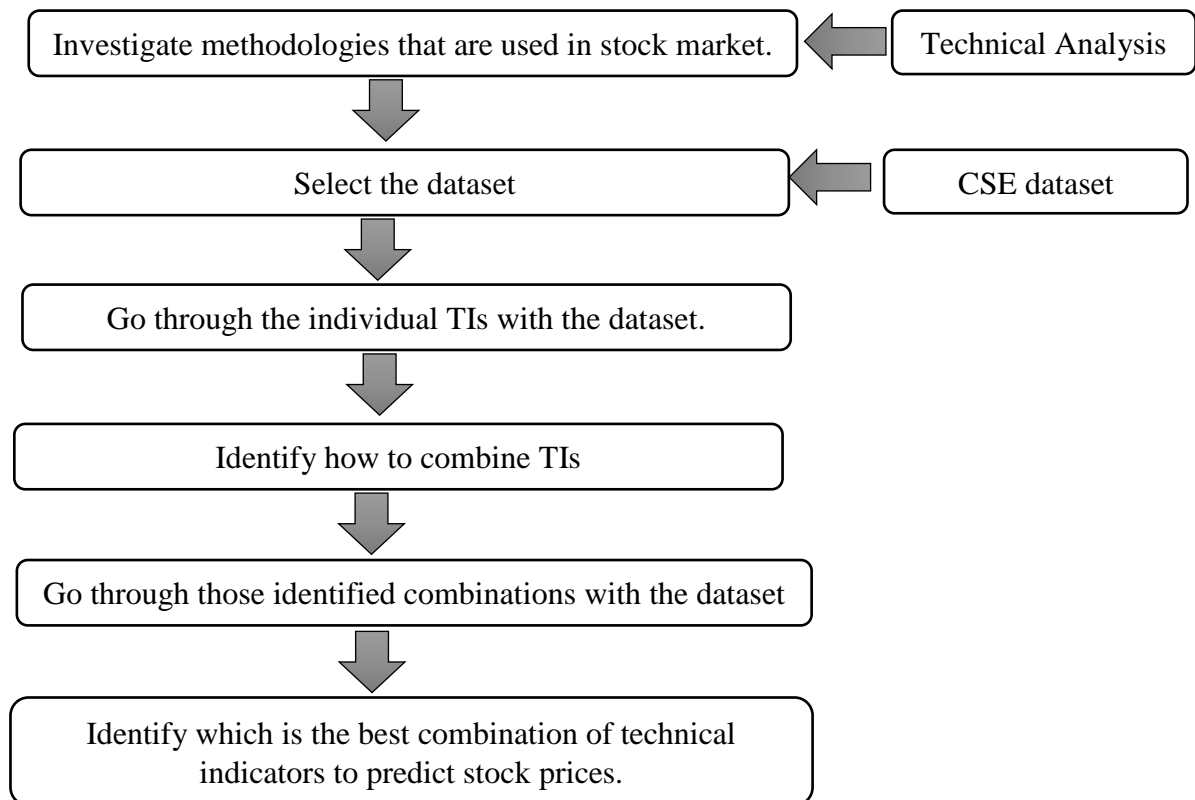
Figure 3. 1: Research Design

Figure 3. 1 illustrates the design of the research. It describes the steps of the research as, investigate methodologies that are used in the stock market. In other words, have to study technical indicators. Then have to select the dataset by using CSE dataset and go through the individual technical indicators with the dataset. Next step is to identify how to combine technical indicators. Then go through those identified combinations with the dataset. Finally, obtained which is the best combination of technical indicators to predict stock prices.

3.3. Data Selection

The source of raw data is CSE. The CSE companies of 333 sectors. To carry on the research daily stock data were taken John Keells Holdings PLC for a period of 17 years starting from January 2, 2002, to March 29, 2018. The dataset consists of approximately 3886 trading day values with Date High, High Price, Date Low, Low Price, Opening Price, Closing Price, Trades, Shares, Turnover, Last Traded Date and Days Traded.

The selected sector details are given in the Table 3. 1.

Company Name	JOHN KEELLS HOLDINGS PLC
Company ID	JKH
Short Name	JKH
Security Type	N
Sub Type	0000

Table 3. 1: Selected Company Details

Stock attributes which are used as the inputs to analysis technical indicators are given in the Table 3. 2.

Attribute	**Description**
Date/ Month	Trading date /month
Date High	Date which has the maximum price of the stock with a specific time period
High Price	Maximum price of stock with a specific time period
Date Low	Date which has the minimum price of the stock with a specific time period
Low Price	Minimum price of stock with a specific time period
Opening Price	Opening price of stock on a trading day
Closing Price	Closing price of stock on a trading day
Trades	Number of trades
Shares	Total volume of shares traded

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Turnover	Total volume of turnover
Last Traded Date	Last trading date
Days Traded	Number of transaction dates of the stock with a specific time period

Table 3. 2: Dataset Attributes

Dataset which is used as the inputs to analysis technical indicators are given in the Figure 3. 2.

Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1
5-Feb-02	5-Feb-02	52.50	5-Feb-02	52.00	52.00	26	13,000	678,850.00	5-Feb-02	1
6-Feb-02	6-Feb-02	52.00	6-Feb-02	52.00	52.00	15	172,300	8,959,600.00	6-Feb-02	1
7-Feb-02	7-Feb-02	52.25	7-Feb-02	50.00	50.00	32	41,900	2,122,650.00	7-Feb-02	1
8-Feb-02	8-Feb-02	50.00	8-Feb-02	48.00	48.25	70	130,100	6,339,050.00	8-Feb-02	1
11-Feb-02	11-Feb-02	49.00	11-Feb-02	48.25	49.00	23	18,200	885,450.00	11-Feb-02	1

Figure 3. 2: Selected Dataset Figure

3.4. Analysis of Technical Indicators

3.4.1. Simple Moving Average

SMA is one of the most popular MA. It smoothed the closing price data from a trend.MA form the building blocks for other technical indicators and overlays, such as Bollinger Band. Considering both SMA and EMA, SMA became the preferred method for tracking market price because they are quick to calculate and easy to understand. Also, SMA gives a clever idea of the overall trend. By considering these facts, proposed research used SMA.

SMA is the average price of stocks over a specific period. SMA is based on the closing price. A 20-day SMA is returned the sum of the last 20-day closing price and divided by 20.

Moving Average don't consider changes that may affect a security's future performance, such as new competitors, higher or lower demand for products in the industry and changes in the managerial structure of the company. They draw trends from past information. Ideally, they will show a consistent change in the price of a security over time. Unfortunately, they don't work for all companies, especially for those in very volatile industries or those that are heavily influenced by current events. They can be spread out over any time period. However, moving average can be problematic because the general trend can change significantly depending on

the time period used. Moving averages have more volatility in shorter time frames, whereas longer time frames have less volatility but don't account for new changes in the market. Investors must be careful which time frame they choose to make sure the trend is clear and applicable.

3.4.2. Exponential Moving Average

EMA is similar SMA, except that more weight is given to the latest data. It's also known as the Exponential Weighted Moving Average. For recent price changes, EMA answers faster than the SMA. Most stockbrokers used EMA for a lengthy period to find the long-term behavior of the market.

3.4.3. Moving Average Convergence Divergence

One of the most powerful and well-known indicators in technical analysis is Moving Average Convergence Divergence. The indicator is comprised of two exponential moving averages that help measure momentum in security. MACD is the difference between two moving averages plotted against a centerline, where the centerline is the point at which the two moving averages are equal. To signal the current direction of momentum MACD compares short-term momentum and long-term momentum rather than the direction of price.

When the MACD is positive, which signals that the short-term moving average is above the long-term moving average and the security's momentum is upward. The opposite is true when the MACD is negative, it signals that the short-term moving average is below the long term average and suggests downward momentum. Figure 3. 3 demonstrates major features of MACD such as centerline, MACD positive and MACD negative.
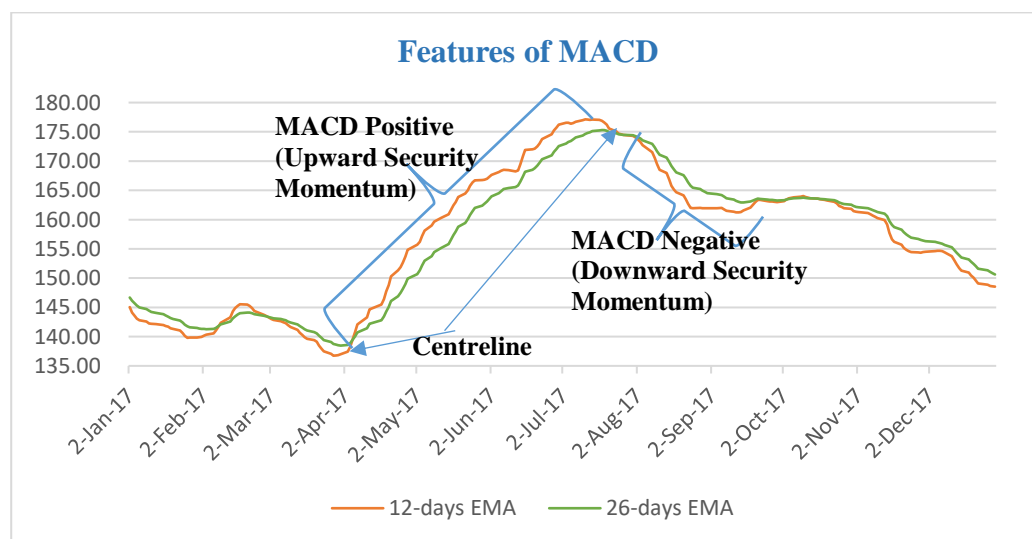
Figure 3. 3: Features of MACD

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3.4.4. Relative Strength Index

RSI is an extremely popular momentum indicator which measures the speed and change of price movements. RSI oscillates between zero and 100. RSI above 70 is considered overbought and below 30 as oversold. Signals can be generated by looking for divergences, failure swings and centerline crossovers. RSI can be used to identify the overall trend.

RSI mentor introduced positive and negative reversals for RSI and, furthermore, turned the notion of divergence, literally and figuratively, on its head.

RSI has been broken down into its basic components as RS, Average Gain and Average Loss. RSI calculation is based on 14 periods. Losses are expressed as positive values but not negative values.

First, calculate previous average gain and average loss for 14-period averages

$$\text{Average Gain }_{previous} = \text{Total Gains during the past 14 periods} / 14$$

$$\text{Average Loss }_{previous} = \text{Total Losses during the past 14 periods} / 14$$

Second, and subsequent, calculations are based on the previous averages and the current gain loss:

$$\text{Average Gain} = [(\text{Average Gain }_{previous}) * 13 + \text{Current Gain}] / 14$$

$$\text{Average Loss} = [(\text{Average Loss }_{previous}) * 13 + \text{Current Loss}] / 14$$

Taking the previous value plus the current value is a smoothing technique similar to that used in calculating an exponential moving average. This means that RSI values become more accurate as the calculation period extends.

Divergences signal a potential reversal point for directional momentum does not confirm price. A bullish divergence occurs once the underlying security makes a lower low and RSI forms a higher low. RSI does not confirm the lower low and this approves strengthening momentum. A bearish divergence forms once the security records a higher high and RSI forms a lower high. RSI does not confirm the new high and this approves weakening momentum.

Positive and negative reversals for RSI, which are the opposite of bearish and bullish deviations. Bearish divergences to be bull market phenomena - in other words, bearish divergences are more likely to form in uptrends. Likewise, bullish divergences are considered bear market phenomena indicative of a downtrend. A positive reversal procedures when RSI forges a lower low and the security forms a higher low. This lower low is not at oversold levels, but usually somewhere in between 30 and 50.

A negative reversal is the against of a positive reversal. RSI procedures a higher high, but the security forms a lower high. Again, the higher high is typically just below overbought levels in the 50-70 area. Even though RSI sham a new high and momentum was strong, the price action failed to confirm as lower high formed.

Figure 3. 4 demonstrates major features of RSI such as centerline, positive reversal, negative reversal, overbought and oversold.
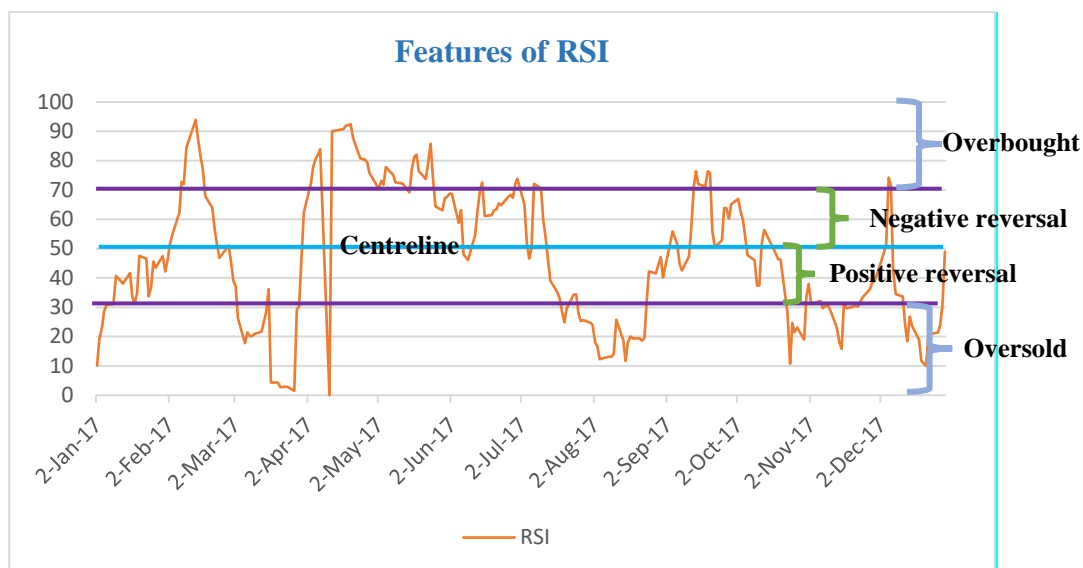
Figure 3. 4: Features of RSI

The RSI itself does the work it was mathematically allocated to do. Real market conditions may not always line up or agree with the technical indicators like any other indicator. Markets are often and dynamic times quite irrational. There is no magic indicator than can predict with certainty when to exit or when to enter a trade. If there was, everyone would use RSI, and there would be no dynamic market as everyone would buy, and everyone would sell at the same time.

3.4.5. Average Price

Average Price or Typical price indicates an average of each day's price. Average Price is calculated by adding high, low, closing price together, and then divided by three.
Average Price is a building block of the Money Flow Volume.

3.4.6. Standard Deviation

Standard deviation is a statistical term that measures the amount of variability around an average. Standard deviation is also a measure of volatility. Standard deviation is the difference between the actual value and the average value. The larger this variability is, the higher the

standard deviation. The smaller this variability is, the lower the standard deviation. Chartists can use the standard deviation to measure the expected risk and determine the significance of certain price movements.

Price changes for securities are not always normally distributed, normal distribution strategies to measure the significance of a price movement. In a normal distribution with a classic bell curve, 68% of the observations fall within one standard deviation, while 95% fall within two and 99.7% fall within three illustrated in Figure 3. 5. Using these strategies, traders can estimate the significance of a price movement. Depending on the direction of the move greater than one standard deviation would show above average strength or weakness.
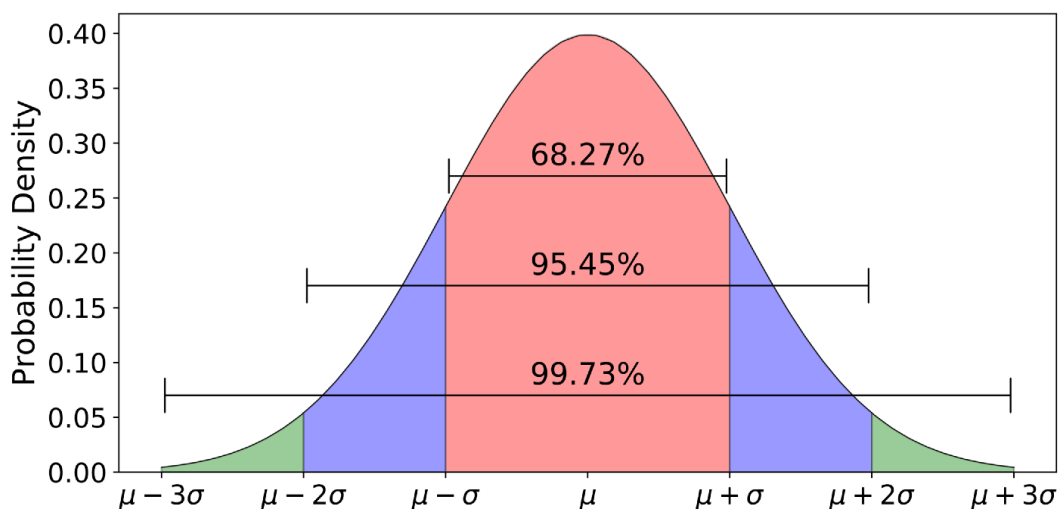
Figure 3. 5: Normal Distribution

The standard deviation is also used with Bollinger Bands. These bands are two standard deviations above and below a moving average. Moves that exceed the bands are considered significant enough to warrant attention.

Standard deviation is strictly defined measure and its value is always fixed. It is based on all the objects in the series. So, it is the best measure of distribution. This is least affected by the sampling variations than other measures. This can be used for mathematical operations and algebraic treatments. It is also applicable in statistical analysis. Standard deviation is difficult to understand and complex to compute as compared to other technical indicators. This is high affected by extreme values in the series. This cannot be obtained for open end class frequency distribution.

3.4.7. Bollinger Band

Bollinger Bands are volatility bands placed above and below a SMA. The purpose of BBs is to measure the "highness" or "lowness" of the price, relative to previous trades. The bands automatically narrow when volatility decreases and widen when volatility increases. This dynamic nature of BBs also means they can be used on different securities with the standard settings. Bollinger band is the most popular technical indicator which is consisted with Simple Moving Average, Upper Band, Lower Band, and Standard Deviation and used to determined volatility of the stock, to identify overbought and oversold.

Bollinger endorses making small incremental adjustments to the standard deviation multiplier. Changing the number of periods for the MA also affects the number of periods used to calculate the standard deviation. Thus, only small adjustments are required for the standard deviation multiplier. An increase in the MA calculation period would automatically increase the number of periods used to calculate the standard deviation and would also warrant an increase in the standard deviation multiplier.

BB is 20-day SMA.

3.4.8. Upper Band

Upper Band is used to create BB and is not a professional indicator but can be used to identify up movements in markets. As price rise to the upper band, the stock becomes more overbought meaning price should fall. If the current price breaks through the upper band it is considered as a sell signal.

The upper band is two standard deviations above the middle band.

3.4.9. Lower Band

Lower Band is used to create BB and is not a professional indicator but can be used to identify down movements in markets. As price moves closer to the lower band stronger the indication is that stock is oversold the price should rise soon. If the current price breaks through the lower band it is, consider a buy signal.

The lower band is two standard deviations below the middle band.

Top

The top is considered the highest close price a specific stock can reach and it's usually followed by a decline of close price to reverse to the downtrend.

Bottom

The bottom is the lowest price that a stock can reach before it shifts upward to begin a new uptrend.

Bollinger Squeeze

The Bollinger Squeeze is self-explanatory. When the bands squeeze together, it means that a breakout is getting ready to happen.

If the candles start to break out above the upper band, then the move will usually continue to go up.

If the candles start to break out below the lower band, then the price will usually continue to go down.

Head and Fake

Head and Fake pattern in the Bollinger band is a rapid break of the opposite band. There is a big run up through the upper band then narrowing the bands (squeezes) and suddenly move to the opposite direction and touches the LB. In the case of a downside move, traders could have been overly exuberant in taking profits after such a big run up to the high.

Bollinger Bounce

Bollinger Bounce occurs when a stock price will bounce off the upper or lower BB and then return towards the middle of the BB.

Classic Bollinger Bounce

Classic Bollinger bounce occurs when BB act like dynamic support and resistance level. Longer the time period you are in, the stronger these bands tend to be. Many traders have developed systems that thrive on these bounces and this approach is best used when the market is ranging and there is no clear trend.

Figure 3. 6 demonstrates major features of BBs such as Bollinger squeeze and the classic Bollinger bounce.
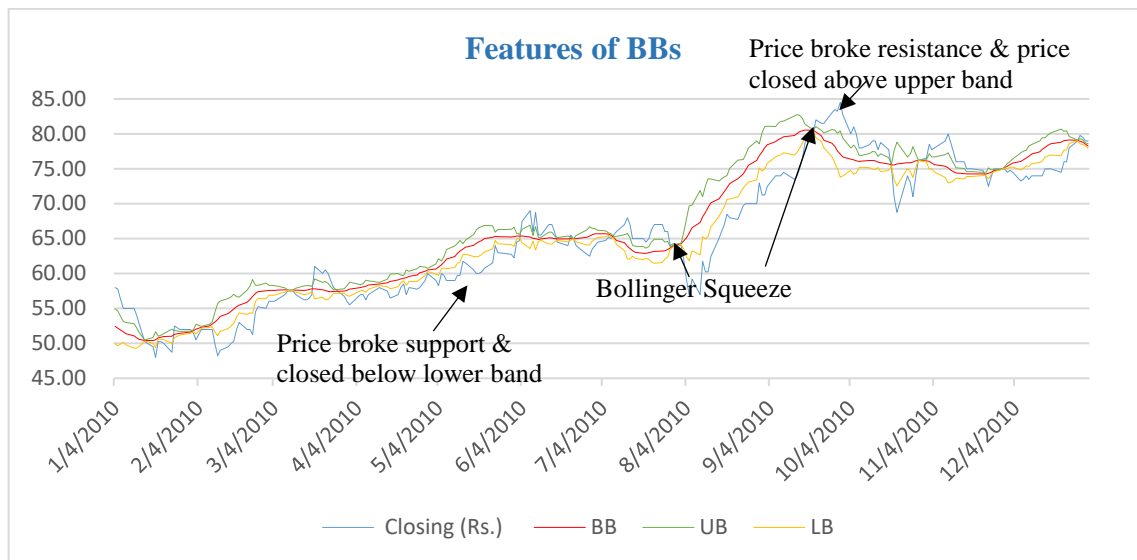
Figure 3. 6: Features of BBs

Although Bollinger Bands are supportive tools for technical traders, there are a few limitations that traders should consider before using them. One of these limitations is that Bollinger Bands are mostly reactive, not predictive. The bands will respond to changes in price movements, either uptrends or downtrends, but will not predict prices. This is because the tool is based on a simple moving average, which takes the average price of several price blocks. Although traders may use the bands to measure the trends, they cannot use the tool alone to make price predictions. Another limitation of Bollinger Bands is that the standard backgrounds will not work for all traders. Traders must find settings that allow them to set strategies for specific stocks that they are trading. If the selected band settings fail to work, traders may change the settings or use a different tool altogether. The effectiveness of Bollinger Bands varies from one market to another, and traders may need to adjust the backgrounds even if they are trading the same security over a period of time.

3.4.10. Bollinger Band Width

Bollinger Band Width is an indicator which consists of a middle band with two outer bands. The middle band is 20-day simple moving average. The outer bands are usually set 2 standard deviations above and below the middle band. To calculate Bollinger Band Width, the first step is to subtract the value of the lower band from the value of the upper band. This shows the absolute difference. This difference divided by the middle band, which normalizes the value.

Bollinger Band Width measures the percentage difference between the upper band and the lower band and it used to identify the Bollinger Band Squeeze. Also, it used to prepare for a

move, but direction depends on the subsequent band break. A squeeze followed by a break above the upper band is bullish, while a squeeze followed by a break below the lower band is bearish. Be careful of head-fakes however because sometimes the first break fails to hold as prices reverse the other way. Strong breaks hold and seldom look back. An upside breakout followed by an immediate pullback should serve as a warning.

Bollinger Bands narrow when Bollinger Band Width decreases and Bollinger Bands widen when Bollinger Band Width increases because Bollinger Bands are based on the standard deviation, rising Bollinger Band Width reflects increasing volatility and falling Bollinger Band Width reflects decreasing volatility.

Narrowness

Narrow Band Width is relative. Bollinger Band Width values should be determined relative to prior Bollinger Band Width values over a period of time. It is important to get a good look-back period to define Bollinger Band Width range for a particular index or stock.

Securities with low volatility have lower Bollinger Band Width values than securities with high volatility.

Figure 3. 7 demonstrates major features of BBW such as Bollinger band squeeze, bullish divergence and bearish divergence.
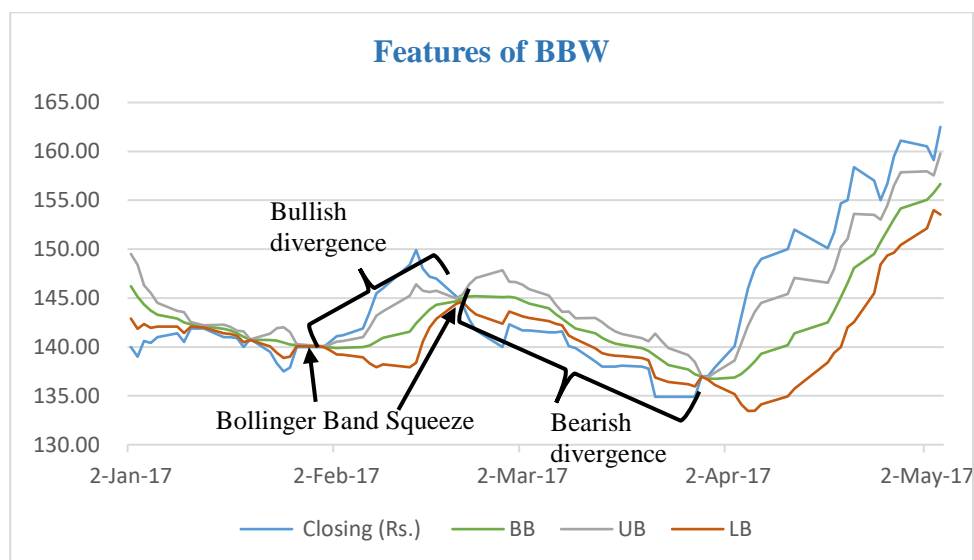
Figure 3. 7: Features of BBW

3.4.11.   Chaikin Money Flow

Chaikin Money Flow measures the amount of Money Flow Volume over a specific period. Money Flow Volume procedures the basis for the Accumulation Distribution Line. The resulting indicator varies above/below the zero line just like an oscillator. Chartists consider the balance of buying or selling pressure with the absolute level of Chaikin Money Flow. Furthermore, chartists can look for crosses above or below the zero line to identify changes on money flow.

CMF is based on 20 periods. First, calculate the Money Flow Multiplier for each period then, multiply this value by the period's volume to find Money Flow Volume. Finally, sum Money Flow Volume for the 20 periods and divide by the 20-period sum of volume.

Each period's Money Flow Volume depends on the Money Flow Multiplier. This multiplier is positive when the close is in the upper half of the period's high-low range and negative when the close is in the lower half. The multiplier equals 1 when the close equals the high and -1 when the close equals the low. Volume is in effect reduced unless the Money Flow Multiplier is at its extremes +1 or -1.

Chaikin Money Flow (CMF) is an oscillator that varies between -1 and +1. Rarely, the indicator reaches these extremes. It would take 20 consecutive closes on the high or low for 20-day Chaikin Money Flow to reach +1 or -1. Naturally, this oscillator fluctuates between -0.50 and +0.50 with 0 as the centerline.

Chaikin Money Flow can be used to describe a general buying or selling bias simply with positive or negative values. The indicator wavers above/below the zero line. Generally, buying weight is stronger when the indicator is positive and selling pressure is stronger when the indicator is negative.

While this zero line cross seems simple enough, the reality is much choppier. Chaikin Money Flow sometimes only briefly crosses the zero line with a move that turns the indicator just positive or negative. There is no follow through and this zero line cross ends up becoming a bad signal. Chartists can filter these signals with buffers by setting the threshold a little below zero (-0.05) and the bullish threshold a little above zero (+0.05). These thresholds will not completely eliminate bad signals, but can help reduce whipsaws and filter out weaker signals.

A move above +0.05 is considered bullish, while a move below -0.05 is considered bearish.

CMF does not account for gaps. This tends to bark twice as with a simple moving average.

3.5. Summary

In this chapter described how to do the research in section research design, which dataset and attributes which are used as the inputs to analysis technical indicators under the data selection. Proposed research used eleven technical indicators. They were Simple Moving Average, Exponential Moving Average, Moving Average Convergence Divergence, Relative Strength Index, Average Price, Standard Deviation, Bollinger Band, Upper Band, Lower Band, Bollinger Band Width and Chaikin Money Flow.

Chapter 4.   Proposed Solution

4.1. Introduction

This chapter provides the proposed solution of this research which is how to obtain the best combination of technical indicators to predict stock price by analyzing the results of individual and combination of technical indicators by using the selected dataset.

4.2. Proposed Solution

As described in section 2.2.1 ignored fundamental analysis because there is no scope for finding out the past trend also the variations in the price trend for this research. As amplified in section 2.2.2 ignored technological analysis. Then select technical analysis because technical analysis which is a most accurate methodology to predict the stock price is coming under technical analysis and also technical indicator is a mathematical calculation that can be applied to a stock's past patterns, like price, volume or even to another technical indicator as described in section 2.2.3. Twenty-three technical indicators were described in section 2.2.3.

From that twenty three technical indicators ignored leading indicators which is described in Categories of Technical Indicators under the section 2.2.3 Technical Analysis or volume indicators which is amplified in Types of Technical Indicators under the section 2.2.3 Technical Analysis because they used a shorter period than the lagging indicators in the calculation and used to measure the strength of a trend or confirm a trading direction based on some form of averaging or smoothing of raw volume. Then select trend indicators, momentum indicators which is amplified in Categories of Technical Indicators under the section 2.2.3 Technical Analysis and volatility indicators which is described in Types of Technical Indicators under the section 2.2.3 Technical Analysis that belongs to the lagging category because they are confirming patterns that in progress and can use long period than leading indicators in the calculation by that can identify a clear pattern to get the knowledge. After that select RSI which is described in Technical Indicators under the section 2.2.3 Technical Analysis technical indicator which belongs to momentum type and leading category because it consists of EMA.

Finally, eleven technical indicators are selected. They are Simple Moving Average, Exponential Moving Average, Moving Average Convergence Divergence, Relative Strength Index, Average Price, Standard Deviation, Bollinger Band, Upper Band, Lower Band, Bollinger Band Width and Chaikin Money Flow.

Selected technical indicators were combined with diverse ways to predict if the day's closing price would increase or decrease and ignored combinations which gave more variance by analyzing the strength and weaknesses of technical indicators which is amplified in section 3.4

4.2.1. Analysis of Individual Technical Indicators

Simple Moving Average

Calculation formula

$$14\text{-day SMA} = \text{Sum (Closing Prices in last 14 days)} / 14$$

Figure 4. 1 illustrates the results of 14-day SMA calculation and Figure 4. 2 demonstrates the graphical view of 14-day SMA.

Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	SMA
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	53.00
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	52.34
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	51.96
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	51.66
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	51.45
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	51.20
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	50.88
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	50.73

Figure 4. 1: SMA Calculation

Figure 4. 2: Analysis of SMA

In this graphical view can be obtained Simple Moving Average has smoothed the closing price from a trend.

Exponential Moving Average

Calculation formula

14-day Exponential Moving Average = 14-day EMA

= (Current Closing Price – Previous 14-day EMA) * K + Previous 14-day EMA

Smoothing Constant = K = 2 / (n+1)

n = number of periods = 14-days

Figure 4. 3 illustrates the results of 14-day EMA calculation and Figure 4. 4 demonstrates the graphical view of 14-day EMA.

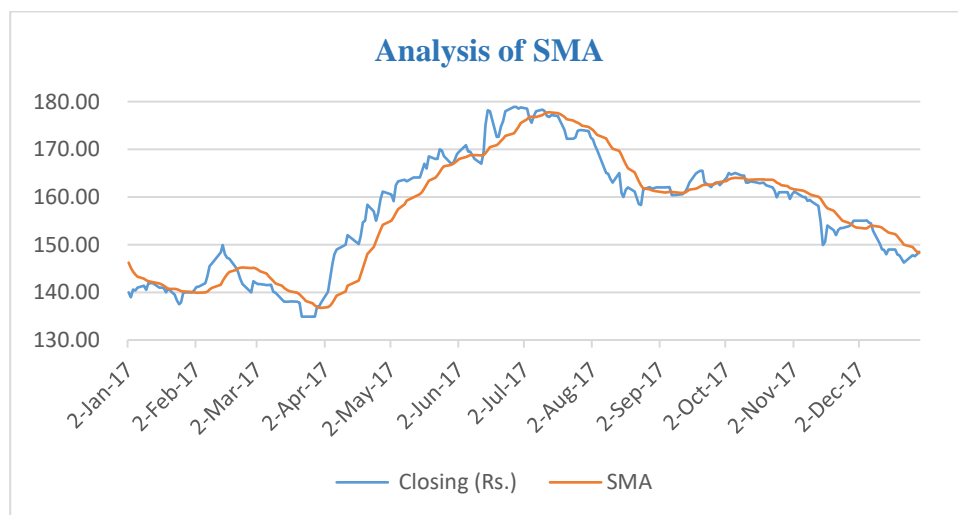| Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	14-days EMA
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	53.00
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	52.43
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	52.44
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	52.38
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	52.33
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	52.22
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	51.99
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	51.99

Figure 4. 3: EMA Calculation
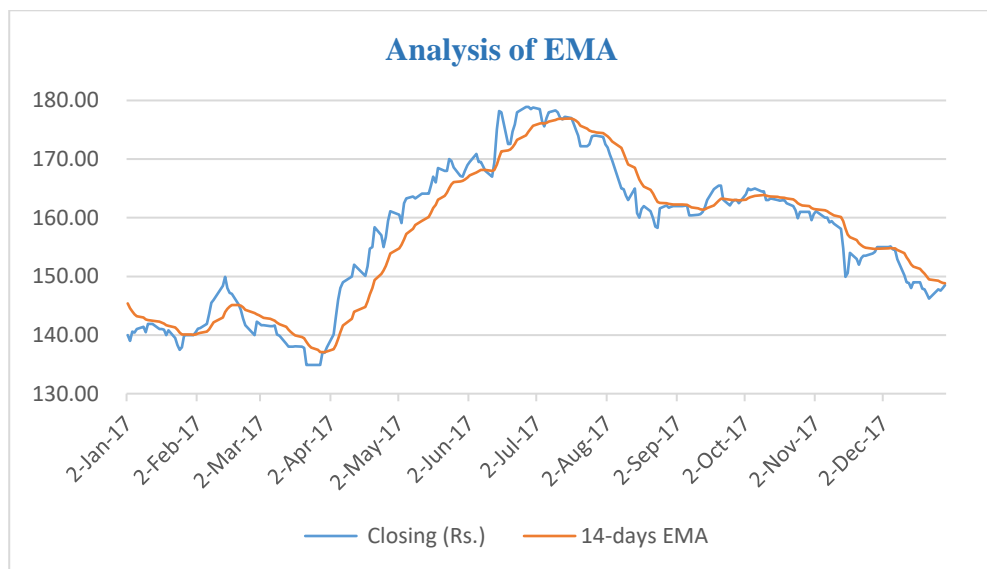
Figure 4. 4: Analysis of EMA

In this graphical view can be obtained Exponential Moving Average has smoothed the closing price from a trend.

Moving Average Convergence Divergence

Calculation formula

n-day Exponential Moving Average = n-day EMA = EMAn

= (Current Closing Price – Previous n-day EMA) * K + Previous n-day EMA

Smoothing Constant = K = 2 / (n+1)

n = number of periods

EMA12 = (Current Closing Price – Previous 12-day EMA) * K + Previous 12-day EMA

Smoothing Constant = K = 2 / (n+1)

n = number of periods = 12-days

EMA26 = (Current Closing Price – Previous 26-day EMA) * K + Previous 26-day EMA

Smoothing Constant = K = 2 / (n+1)

n = number of periods = 26-days

MACD = EMA12 - EMA26

Figure 4. 5 illustrates the results of MACD calculation.

Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	12-days EMA	26-days EMA	MACD = EMA12 - EMA26
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	-	-	0.00
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	-	-	0.00
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	-	-	0.00
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	-	-	0.00
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	-	-	0.00
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	-	-	0.00
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	-	-	0.00
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	-	-	0.00
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	-	-	0.00
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	-	-	0.00
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	-	-	0.00
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	53.48	-	0.00
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	52.98	-	0.00
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	52.52	-	0.00
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	51.94	-	0.00
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	52.03	-	0.00
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	52.02	-	0.00
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	52.02	-	0.00
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	51.94	-	0.00
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	51.72	-	0.00

Figure 4. 5: MACD Calculation

Figure 4. 6 demonstrates the analysis of MACD with EMA12 and EMA26.
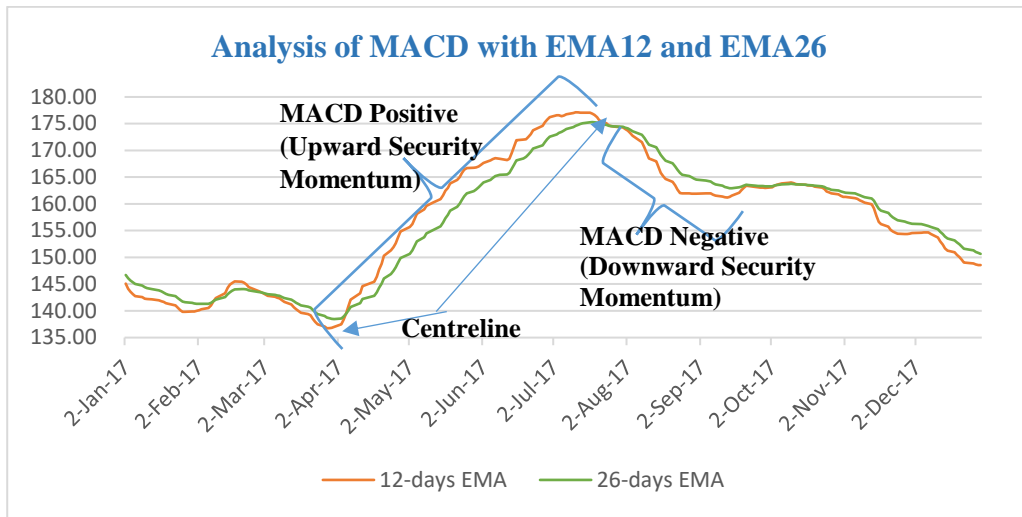
Figure 4. 6: Analysis of MACD with EMA12 and EMA26

In this graphical view can be obtained major features of long term EMA and short term EMA, the centerline occurred when 12-days EMA is equal to 26-days EMA. MACD Positive (Upward Security Momentum) occurred when 12-days EMA is greater than 26-days EMA. MACD Negative (Downward Security Momentum) occurred when12-days EMA is less than 26-days EMA.

Figure 4. 7 demonstrates the graphical view of MACD.
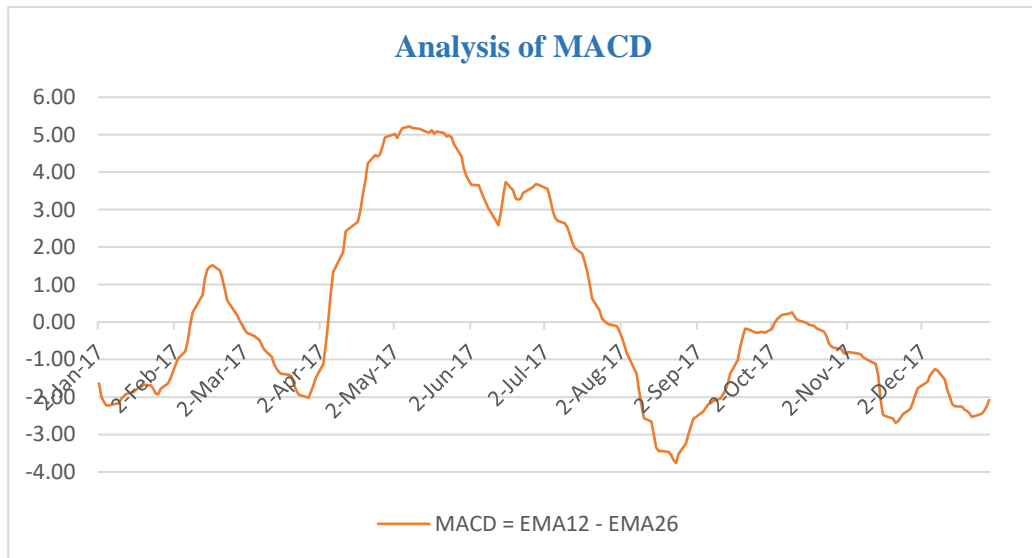
Figure 4. 7: Analysis of MACD

In this graphical view can be obtained major features of MACD, MACD is deviating around closing price from a trend. MACD is zero when 12-days EMA is equal to 26-days EMA. Which means short term EMA is equal to long term EMA. As well as Figure 4. 6 represented Centerline. MACD is greater than zero when 12-days EMA is greater than 26-days EMA.

Which means short term EMA is greater than long term EMA. As well as Figure 4. 6 represented MACD Positive. MACD less than zero when occurring 12-days EMA is less than 26-days EMA. Which means short term EMA is less than long term EMA. As well as Figure 4. 6 represented MACD Negative.

Relative Strength Index

Calculation formula

$$RSI = 100-(100/[1+RS])$$

$$RS = AG/AL$$

$$AG = [(PAG)*13+CG]/14$$

$$AL = [(PAL)*13+CL]/14$$

$$PAG = \text{Total gain during past 14 periods}/14$$

$$PAL = \text{Total losses during past 14 periods}/14$$

AG=Average Gain

AL= Average Loss

PAG = Previous Average Gain

PAL=Previous Average Loss

CG=Current Gain

CL = Current Loss

Figure 4. 8 illustrates the results of RSI calculation and Figure 4. 9 demonstrates the graphical view of RSI.

| Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	Change	Current Gain	Current Loss	Average Gain	Average Loss	RS	RSI
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	(0.25)		0.25				
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	(1.50)		1.5				
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	(1.25)		1.25				
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	-						
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	-						
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	(1.00)		1				
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	(1.25)		1.25				
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	(2.50)		2.5				
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	(0.75)		0.75				
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	(1.50)		1.5				
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	2.25	2.25					
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	-						
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	(0.25)		0.25				
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	(1.25)		1.25	0.160714286	0.821428571	0.1956522	16.363636
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	3.75	3.75		0.428571429	0.803571429	0.5333333	34.782609
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	(0.50)		0.5	0.428571429	0.732142857	0.5853659	36.923077
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	-			0.428571429	0.642857143	0.6666667	40
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	(0.50)		0.5	0.428571429	0.678571429	0.6315789	38.709677
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	(1.00)		1	0.428571429		0.75	0.5714286	36.363636
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	1.50	1.5		0.535714286	0.678571429	0.7894737	44.117647
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	-			0.535714286	0.589285714	0.9090909	47.619048

Figure 4. 8: RSI Calculation
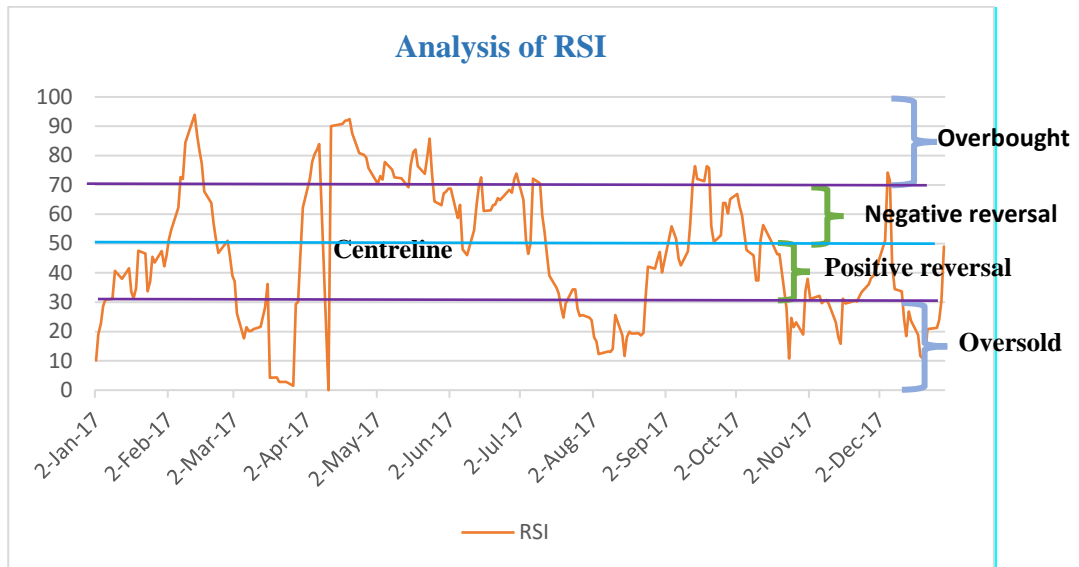
Figure 4. 9: Analysis of RSI

In this graphical view can be obtained major features of RSI, RSI is deviating around closing price from a trend. When RSI is equal to 50 it became the centerline. Positive reversal happened when RSI is in between 30 and 50. Negative reversal occurred when RSI is in between 50 and 70. Overbought occurred when RSI is above 70.Oversold occurred when RSI is below 30.

Average Price

Calculation formula

Average Price = (H+L+C)/3

H=High value of the daily share

L = Low value of the daily share

C=Close value of the daily share

Figure 4. 10 illustrates the results of Average Price calculation and Figure 4. 11 demonstrates the graphical view of Average Price.

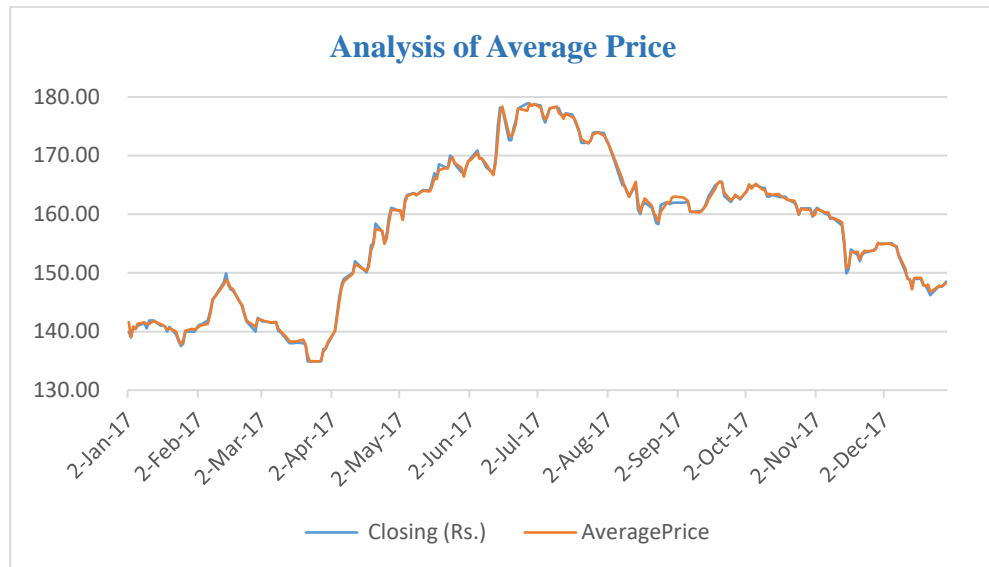| Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	AveragePrice
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	58.67
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	57.25
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	56.75
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	55.83
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	55.33
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	55.33
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	54.33
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	53.08
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	50.08
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	49.83
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	48.58
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	49.50
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	50.25
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	50.08
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	49.08
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	51.25
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	52.17
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	51.83
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	51.67
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	50.75
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	51.58

Figure 4. 10: Average Price Calculation

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Figure 4. 11: Analysis of Average Price

In this graphical view can be obtained Average Price is smoothed the closing price from a trend.

Standard Deviation

Calculation formula

$\sigma 2 = [\text{ sum } (Pi - \mu)2] / n$

$\sigma 2$ – Variance

σ - standard deviation = Positive square root of the variance

n - number of values = 14 days

Pi = Each value of the sample

μ = mean of the values

Figure 4. 12 illustrates the results of Standard Deviation calculation and Figure 4. 13 demonstrates the graphical view of Standard Deviation.

Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	Std
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	-
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	-
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	-
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	-
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	-
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	-
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	-
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	-
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	-
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	-
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	-
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	-
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	-
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	0.80
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	0.96
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	0.14
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	0.09
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	0.15
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	0.08
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	0.10
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	0.34

Figure 4. 12: Standard Deviation Calculation

40
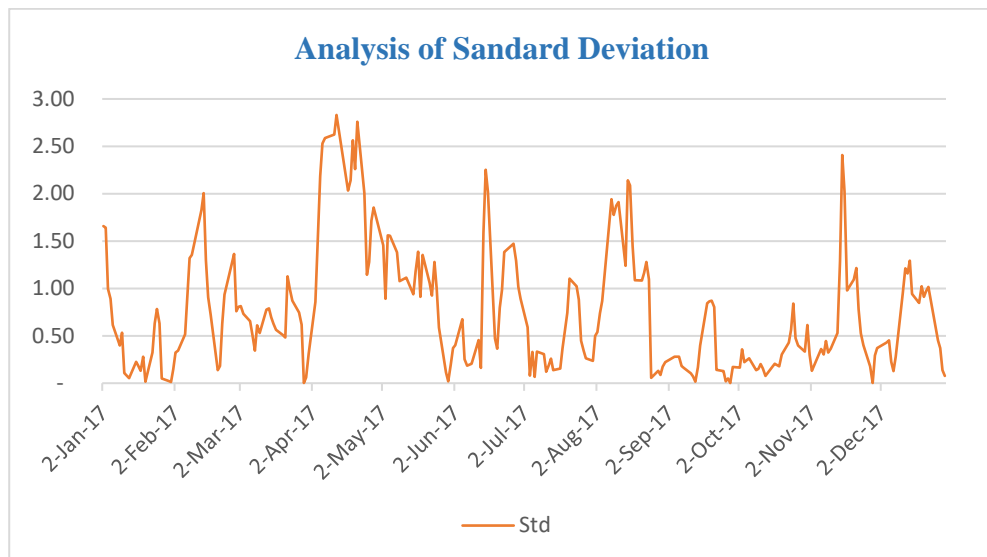
Figure 4. 13: Analysis of Standard Deviation

In this graphical view can be obtained Standard Deviation is deviating around the closing price from a trend. Standard Deviation becomes zero when the closing price of the stock with a specific time period is equal.

Bollinger Bands

Calculation formulas

        14-day SMA = Sum (Closing Prices in last 14 days) / 14

        Bollinger Band = Middle Band = 14-day SMA

        Deviation = 14-day SMA – Closing Price

        Deviation squared = Deviation * Deviation

        Variance = Average 14-day deviation squared

        Standard Deviation = Sqrt (Variance)

        Upper Band = 14-day SMA + (14-day standard deviation * 2)

        Lower Band = 14-day SMA - (14-day standard deviation * 2)

Figure 4. 14 illustrates the results of BBs calculation, Figure 4. 15 demonstrates the analysis of BBs.

Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	BB	Std	UB	LB
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1				
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1				
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1				
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1				
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1				
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1				
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1				
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1				
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1				
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1				
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1				
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1				
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1				
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	53.00	0.80	54.603567	51.396433
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	52.34	0.96	54.25784	50.420732
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	51.96	0.14	52.250637	51.677934
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	51.66	0.09	51.84207	51.479358
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	51.45	0.15	51.742325	51.150532
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	51.20	0.08	51.358694	51.034163
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	50.88	0.10	51.075446	50.674554
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	50.73	0.34	51.409841	50.054445

Figure 4. 14: BBs Calculation
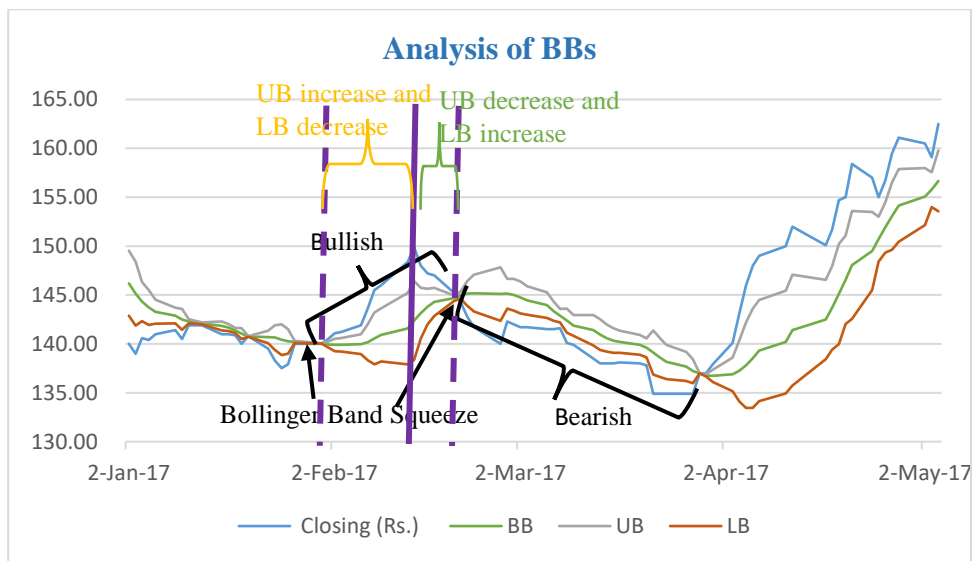
Figure 4. 15: Analysis of BBs

In this graphical view can be obtained major features of BBs, BBs are smoothed the closing price from a trend. The Bollinger squeeze occurred when BB, UB and LB are equal. In other words, when the standard deviation is zero Bollinger squeeze has occurred. Bullish trend occurred when the closing price is above the Upper Band. Bearish trend happened when the closing price is below the Lower Band. When UB is increased and LB is decreased, the difference between UB and LB is increased. It means the standard deviation is increased. At that time BBW is increased and the Bollinger band is getting narrow. When UB is decreased and LB is increased, the difference between UB and LB is decreased. It means the standard deviation is decreased. At that time BBW is decreased and the Bollinger band is getting widened.

Bollinger Band Width

<u>Calculation formulas</u>

14-day SMA = Sum (Closing Prices in last 14 days) / 14

Bollinger Band = Middle Band = 14-day SMA

Deviation = 14-day SMA – Closing Price

Deviation squared = Deviation * Deviation

Variance = Average 14-day deviation squared

Standard Deviation = Sqrt (Variance)

Upper Band = 14-day SMA + (14-day standard deviation * 2)

Lower Band = 14-day SMA - (14-day standard deviation * 2)

Bollinger Band Width = (Upper Band – Lower Band) / Middle Band

Figure 4. 16 illustrates the results of BBW calculation, Figure 4. 17 demonstrates the analysis of BBW with BBs and Figure 4. 18 demonstrates the analysis of BBW.

Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	BB	UB	LB	BBW
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	-	-	0.00	-
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	-	-	0.00	-
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	-	-	0.00	-
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	-	-	0.00	-
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	-	-	0.00	-
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	-	-	0.00	-
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	-	-	0.00	-
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	-	-	0.00	-
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	-	-	0.00	-
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	-	-	0.00	-
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	-	-	0.00	-
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	-	-	0.00	-
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	-	-	0.00	-
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	53.00	54.60	51.40	0.06
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	52.34	54.26	50.42	0.07
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	51.96	52.25	51.68	0.01
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	51.66	51.84	51.48	0.01
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	51.45	51.74	51.15	0.01
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	51.20	51.36	51.03	0.01
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	50.88	51.08	50.67	0.01

Figure 4. 16: BBW Calculation

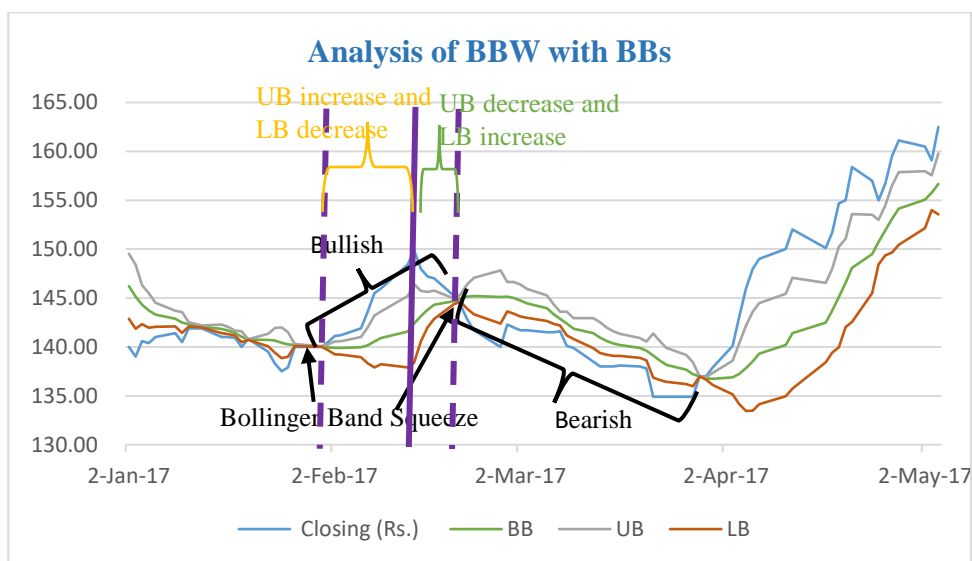
Figure 4. 17: Analysis of BBW with BBs

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In this graphical view can be obtained major features of BBW, the Bollinger squeeze has occurred when BB, UB and LB are equal. In other words, the standard deviation is zero Bollinger squeeze has occurred. The bullish trend occurred when the closing price is above the Upper Band. Bearish trend has happened when the closing price is below the Lower Band. When UB is increased and LB is decreased, the difference between UB and LB is increased. It means the standard deviation is increased. At that time BBW is increased and the Bollinger band is getting narrow. When UB is decreased and LB is increased, the Difference between UB and LB is decreased. It means the standard deviation is decreased. At that time BBW is decreased and the Bollinger band is getting widened.
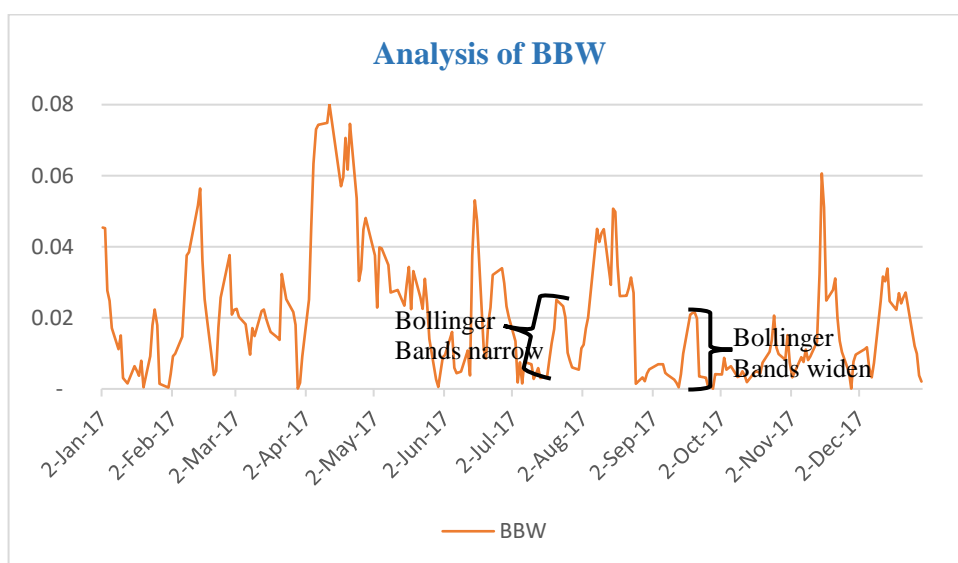
Figure 4. 18: Analysis of BBW

In this graphical view can be obtained major features of BBWs, BBWs deviates around the closing price from a trend. Bollinger Bands is getting narrow when BBW is increased. To increase the BBW the difference between UB and LB has to be increased. Therefore, UB has to be increased and LB has to be decreased. In other words, the standard deviation has to be increased. Bollinger Bands is getting widen when BBW is decreased. To decrease the BBW the difference between UB and LB has to be decreased. Therefore, UB has to be decreased and LB has to be increased. In other words, the standard deviation has to be decreased. Difference between UB and LB is zero BBW became zero. Therefore, UB must be equal to LB. It means the standard deviation must be zero. In other words, BBW is equal to zero when the BB, UB and LB are equal. At that time Bollinger squeeze occurred.

Chaikin Money Flow

<u>Calculation formulas</u>

CMF = sum (AD, n)/sum (VOL, n)

AD = VOL{(CL-OP)/(HI-LO)}

AD - Accumulation Distribution, where n=Period = 20 days

CL=today's closing price

OP=today's opening price

HI=High Value

LO=Low value

Figure 4. 19 illustrates the results of CMF calculation, Figure 4. 20 demonstrates the analysis of CMF.

| Date	Date High	High (Rs.)	Date Low	Low (Rs.)	Closing (Rs.)	Trades(No.)	Shares(No.)	Turnover(Rs.)	Last Traded Date	Days Traded	Multiplier = [(Close - Low) - (High - Close)] /(High - Low)	Money Flow Volume = Money Flow Multiplier x Volume for the Period	20-period CMF = 20-period Sum of Money Flow Volume / 20 period Sum of Volume
2-Jan-02	2-Jan-02	61.00	2-Jan-02	57.00	58.00	55	34,100	1,981,025.00	2-Jan-02	1	0.75	25,575.00	0
3-Jan-02	3-Jan-02	58.00	3-Jan-02	56.00	57.75	36	60,400	3,467,625.00	3-Jan-02	1	0.22	13,212.50	0
4-Jan-02	4-Jan-02	57.75	4-Jan-02	56.25	56.25	32	25,600	1,451,525.00	4-Jan-02	1	-	-	0
7-Jan-02	7-Jan-02	57.50	7-Jan-02	55.00	55.00	134	265,900	14,720,100.00	7-Jan-02	1	-	-	0
8-Jan-02	8-Jan-02	56.00	8-Jan-02	55.00	55.00	51	712,900	39,309,850.00	8-Jan-02	1	-	-	0
9-Jan-02	9-Jan-02	56.00	9-Jan-02	55.00	55.00	112	1,056,800	58,127,100.00	9-Jan-02	1	-	-	0
10-Jan-02	10-Jan-02	55.00	10-Jan-02	54.00	54.00	36	1,025,400	55,375,975.00	10-Jan-02	1	-	-	0
11-Jan-02	11-Jan-02	54.00	11-Jan-02	52.50	52.75	52	66,500	3,535,050.00	11-Jan-02	1	0.21	13,854.17	0
15-Jan-02	15-Jan-02	52.50	15-Jan-02	47.50	50.25	119	145,800	7,312,300.00	15-Jan-02	1	1.24	180,427.50	0
16-Jan-02	16-Jan-02	50.50	16-Jan-02	49.50	49.50	61	40,100	2,002,775.00	16-Jan-02	1	-	-	0
17-Jan-02	17-Jan-02	50.25	17-Jan-02	47.50	48.00	80	134,600	6,484,450.00	17-Jan-02	1	0.41	55,063.64	0
18-Jan-02	18-Jan-02	50.25	18-Jan-02	48.00	50.25	70	260,700	12,618,700.00	18-Jan-02	1	-	-	0
21-Jan-02	21-Jan-02	50.50	21-Jan-02	50.00	50.25	68	238,900	11,988,525.00	21-Jan-02	1	0.13	29,862.50	0
22-Jan-02	22-Jan-02	50.25	22-Jan-02	50.00	50.00	76	201,100	10,065,500.00	22-Jan-02	1	-	-	0
23-Jan-02	23-Jan-02	50.00	23-Jan-02	48.50	48.75	24	8,600	425,600.00	23-Jan-02	1	0.21	1,791.67	0
24-Jan-02	24-Jan-02	53.00	24-Jan-02	48.25	52.50	117	3,988,700	206,455,150.00	24-Jan-02	1	0.45	1,784,418.42	0
25-Jan-02	25-Jan-02	52.50	25-Jan-02	52.00	52.00	47	135,100	7,027,550.00	25-Jan-02	1	-	-	0
29-Jan-02	29-Jan-02	52.00	29-Jan-02	51.50	52.00	29	80,600	4,174,050.00	29-Jan-02	1	-	-	0
30-Jan-02	30-Jan-02	52.00	30-Jan-02	51.50	51.50	22	42,500	2,202,500.00	30-Jan-02	1	-	-	0
31-Jan-02	31-Jan-02	51.25	31-Jan-02	50.50	50.50	29	45,300	2,292,125.00	31-Jan-02	1	-	-	0.245543011
1-Feb-02	1-Feb-02	52.25	1-Feb-02	50.50	52.00	37	511,700	26,597,500.00	1-Feb-02	1	0.21	109,650.00	0.241873772

Figure 4. 19: CMF Calculation
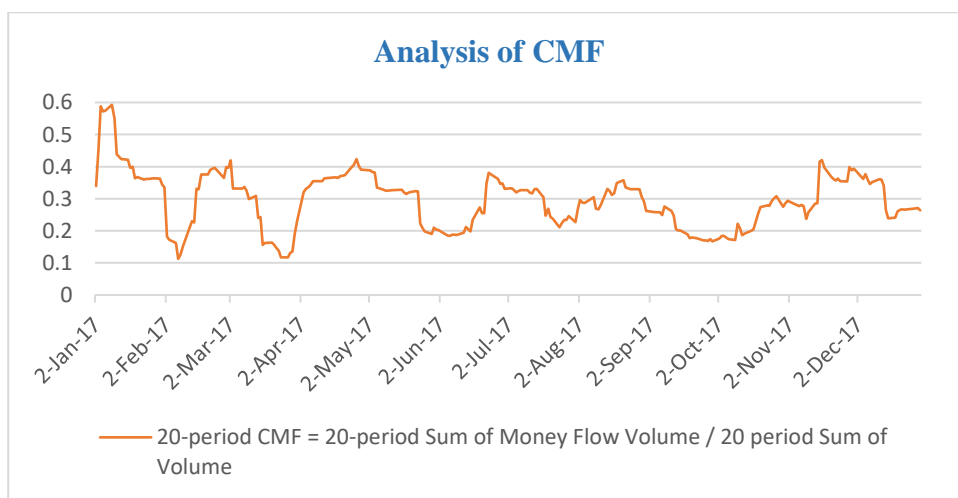
Figure 4. 20: Analysis of CMF

In this graphical view can be obtained major features of CMF, CMF is deviating around the closing price from a trend.

4.2.2. Analysis of Combination of Technical Indicators

To analyze the combination of technical indicators above selected technical indicators were divided into two groups based on the analysis amplified in section 4.2.2.

Group A – Technical Indicators which are smoothed the closing price from a trend.

Group B – Technical Indicators which deviate around closing price from a trend.

Grouping of technical indicators are illustrated in Table 4. 1.

Group A	Group B
A1) Simple Moving Average	B1) Moving Average Convergence Divergence
A2) Bollinger Band	B2) Standard Deviation
A3) Upper Band	B3) Chaikin Money Flow
A4) Lower Band	B4) Bollinger Band Width
A5) Average Price	
A6) Exponential Moving Average	
A7) Relative Strength Index	

Table 4. 1: Grouping of Technical Indicators

Experiment 1 – How to combine Group A Technical Indicators and Identify which combination is best.

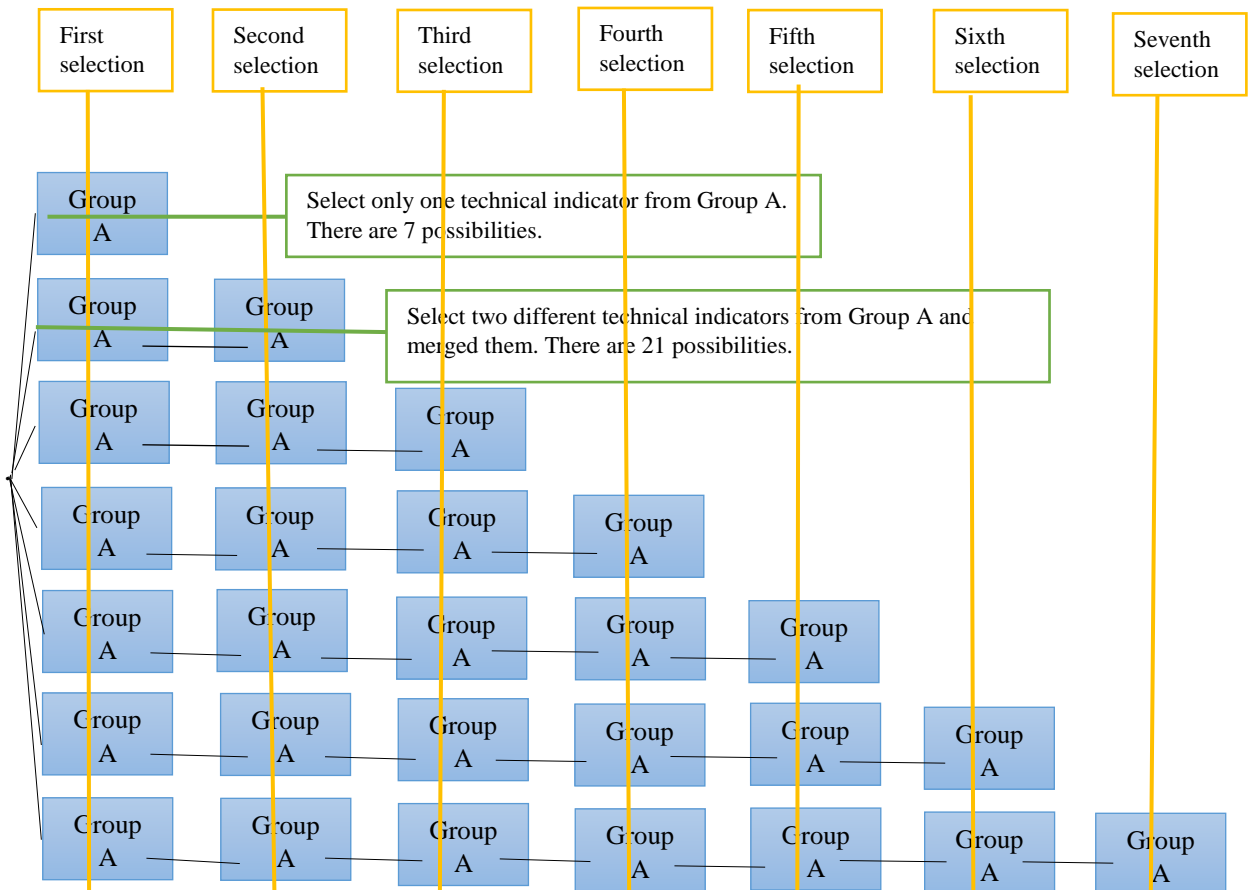Combination of Group A technical indicators are illustrated in Figure 4. 21.

Figure 4. 21: Possibilities which can merge Group A technical indicators

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In this figure describes,

First Selection

Select only one technical indicator from Group A.

$n(A^1) = $ Select one technical indicator from Group A

$$= C_{(7,\ 1)} = \frac{7!}{1!\ 6!} = 7$$

$A^1 = \{$ A1, A2, A3, A4, A5, A6, A7 $\}$

Second Selection

Select two different technical indicators from Group A and merged them by receiving the average of two technical indicators. In other words, first selection merged with different technical indicator.

$n(A^2) = $ Select two different technical indicator from Group A

$$= C_{(7,\ 2)} = \frac{7!}{2!\ 5!} = \frac{6*7}{2} = 21$$

$A^2 = \{$ A1A2, A1A3, A1A4, A1A5, A1A6, A1A7, A2A3, A2A4, A2A5, A2A6, A2A7, A3A4, A3A5, A3A6, A3A7, A4A5, A4A6, A4A7, A5A6, A5A7, A6A7 $\}$

Third Selection

Select three different technical indicators from Group A and merged them by receiving the average of three technical indicators. In other words, results obtained from the second selection merged with different technical indicator.

$n(A^3) = $ Select three different technical indicator from Group A

$$= C_{(7,\ 3)} = \frac{7!}{3!\ 4!} = \frac{5*6*7}{2*3} = 35$$

$A^3 = \{$ A1A2A3, A1A2A4, A1A2A5, A1A2A6, A1A2A7, A1A3A4, A1A3A5, A1A3A6, A1A3A7, A1A4A5, A1A4A6, A1A4A7, A1A5A6, A1A5A7, A1A6A7, A2A3A4, A2A3A5, A2A3A6, A2A3A7, A2A4A5, A2A4A6, A2A4A7, A2A5A6, A2A5A7, A2A6A7, A3A4A5, A3A4A6, A3A4A7, A3A5A6, A3A5A7, A3A6A7, A4A5A6, A4A5A7, A4A6A7, A5A6A7 $\}$

Fourth Selection

Select four different technical indicators from Group A and merged them by receiving the average of four technical indicators. In other words, results obtained from the third selection merged with different technical indicator.

$n(A^4) = $ Select four different technical indicator from Group A

$$= C_{(7,\ 4)} = \frac{7!}{4!\ 3!} = \frac{5*6*7}{2*3} = 35$$

A^4 = { A1A2A3A4, A1A2A3A5, A1A2A3A6, A1A2A3A7, A1A2A4A5, A1A2A4A6, A1A2A4A7, A1A2A5A6, A1A2A5A7, A1A2A6A7, A1A3A4A5, A1A3A4A6, A1A3A4A7, A1A3A5A6, A1A3A5A7, A1A3A6A7, A1A4A5A6, A1A4A5A7, A1A4A6A7, A1A5A6A7, A2A3A4A5, A2A3A4A6, A2A3A4A7, A2A3A5A6, A2A3A5A7, A2A3A6A7, A2A4A5A6, A2A4A5A7, A2A4A6A7, A2A5A6A7, A3A4A5A6, A3A4A5A7, A3A4A6A7, A3A5A6A7, A4A5A6A7}

Fifth Selection

Select five different technical indicators from Group A and merged them by receiving the average of five technical indicators. In other words, results obtained from the fourth selection merged with different technical indicator.

$n(A^5)$ = Select five different technical indicator from Group A

$$= C_{(7, \ 5)} = \frac{7!}{5! \ 2!} = \frac{6*7}{2} = 21$$

A^5 = { A1A2A3A4A5, A1A2A3A4A6, A1A2A3A4A7, A1A2A3A5A6, A1A2A3A5A7, A1A2A3A6A7, A1A2A4A5A6, A1A2A4A5A7, A1A2A4A6A7, A1A2A5A6A7, A1A3A4A5A6, A1A3A4A5A7, A1A3A4A6A7, A1A3A5A6A7,A1A4A5A6A7, A2A3A4A5A6, A2A3A4A5A7, A2A3A4A6A7, A2A3A5A6A7, A2A4A5A6A7, A3A4A5A6A7}

Sixth Selection

Select six different technical indicators from Group A and merged them by receiving the average of six technical indicators. In other words, results obtained from the fifth selection merged with different technical indicator.

$n(A^6)$ = Select six different technical indicator from Group A

$$= C_{(7, \ 6)} = \frac{7!}{6! \ 1!} = 7$$

A^6 = { A1A2A3A4A5A6, A1A2A3A4A5A7, A1A2A3A4A6A7, A1A2A3A5A6A7, A1A2A4A5A6A7, A1A3A4A5A6A7, A2A3A4A5A6A7 }

Seventh Selection

Select seven different technical indicators from Group A and merged them by receiving the average of seven technical indicators. In other words, results obtained from the sixth selection merged with different technical indicator.

$n(A^7)$ = Select seven different technical indicator from Group A

$$= C_{(7, \ 7)} = \frac{7!}{7! \ 0!} = 1$$

A^7 = { A1A2A3A4A5A6A7 }

To identify the best combination of Group A, go through the following steps.

A^{ALL} = All selections of Group A = { $A^1, A^2, A^3, A^4, A^5, A^6, A^7$ }

Step 0 :- Select one from (A^{ALL}) = { A^2 }

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

Step 2 :- Obtained results of A^2 which means obtained the results by merging two different technical indicators from Group A.

Step 3 :- Plotted a graph with obtained results.

Step 4 :- Identify the best combination of A^2 which means identify which combination demonstration the smallest difference between the closing price and the combination.

Step 5 :- Repeat Step 0 to Step 3 up until all the selection of Group A.

Step 6 :- Plotted all the best combinations obtained from Step 3.

Step 7 :- Identify the best combination of A^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination.

For example,

      C = Closing Price

      P = {p_1, p_2, p_3 } ; p_1 is equal to p_3.

      P^1 = select one from P = { p_1, p_2, p_3}

      P^2 = select two different from P = { $(p_1p_2), (p_2p_3), (p_1p_3)$}

      P^3 = select three different from P = { $(p_1p_2p_3)$}

      P^{ALL} = All selections of P = { P^1, P^2 } = { $p_1, p_2, (p_1p_2)$ }

Identify the best combination of P^{ALL}

Identify the best combination of P^{ALL}

To identify the best combination of P^{ALL}, have to identify the best combination of P^1 and P^2 separately.

      Identify the best combination of P^1

          $|p_1 - C| = |p_3 - C|$ (because $p_{1=p_3}$)

          Assume:- $|p_1 - C| < |p_2 - C|$

          Conclusion:- best combination of P^1 is p_1

                (because $|p_1 - C|$ is smaller than $|p_2 - C|$)

Identify the best combination of P^2

avg(p_1p_3) = p_1 = p_3 Therefore, ignored the combination of p_1p_3.

avg(p_1p_2)=avg(p_2p_3)   (because p_1 = p_3)

Therefore, only combine one combination from p_1p_2 and p_2p_3.

Conclusion:- best combination of P^2 is p_1p_2

(because P^2 has only one possible possibility)

Identify the best combination of P^3

Conclusion:- best combination of P^3 is $p_1p_2p_3$

(because P^3 has only one possibility)

After identifying p_1, p_1p_2 and $p_1p_2p_3$ are the best combinations of P^1, P^2 and P^3 separately can identify the best combination of P^{ALL}.

Assume:- $| p_1 - C | > | p_1p_2 - C | < | p_1p_2p_3 - C |$

Conclusion:- best combination of P^{ALL} is p_1p_2

(because $| p_1p_2 - C |$ is smaller than $| p_1 - C |$ and $|| p_1p_2p_3 - C |$)

Therefore, the proposed Experiment 1 is a valid solution to identify the best combination of Group A.

Experiment 2 – How to combine Group B Technical Indicators

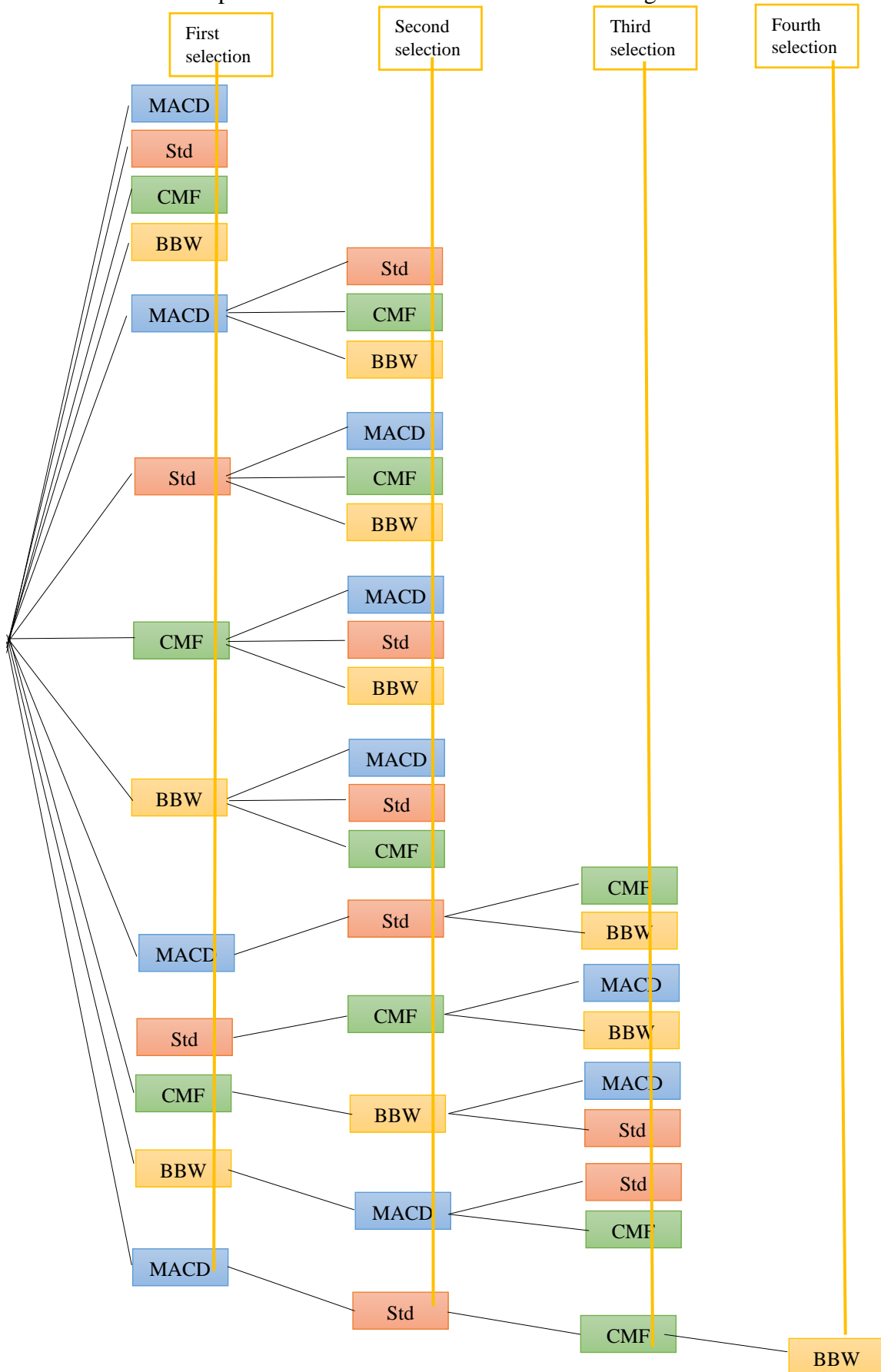Combination of Group B technical indicators are illustrated in Figure 4. 22.

Figure 4. 22: Possibilities which can merge (Average/ Sum) Group B technical indicators

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In this figure describes,

First Selection

Select only one technical indicator from Group B.

$n(B^1)$ = Select one technical indicator from Group B

$$= C_{(4,\ 1)}\ = \frac{4!}{1!\ 3!} = 4$$

B^1 = { B1, B2, B3, B4 }

Second Selection

Select two different technical indicators from Group B and merged them by receiving the average of two technical indicators or the summation of two technical indicators. In other words, first selection merged with different technical indicator and obtained the summation or the average.

$n(B^2)$ = Select two different technical indicators from Group B either summation or average

$$= 2 * C_{(4,\ 2)} = 2 * \frac{4!}{2!\ 2!} = 2 * \frac{3\ *\ 4}{2} = 12$$

B^2 = { Avg(B1B2), Avg(B1B3), Avg(B1B4), Avg(B2B3), Avg(B2B4), Avg(B3B4), Sum(B1B2), Sum(B1B3), Sum(B1B4), Sum(B2B3), Sum(B2B4), Sum(B3B4) }

Third Selection

Select three different technical indicators from Group B and merged them by receiving the average of three technical indicators or the summation of three technical indicators or average of two technical indicators added into another technical indicator. In other words, second selection merged with different technical indicator and obtained the summation or the average.

$n(B^3)$ = Select three different technical indicators from Group B either summation or average + Select three different technical indicators from Group B with summation and average

$$= 2 * C_{(4,\ 3)} +\ C_{(4,\ 2)} * C_{(2,\ 1)}$$

$$= 2 * \frac{4!}{3!\ 1!} + \frac{4!}{2!\ 2!} * \frac{2!}{1!\ 1!} = 2 * 4\ + 3 * 4 = 8 + 12 = 20$$

B^3 = {Avg(B1B2B3), Avg(B1B2B4), Avg(B1B3B4), Avg(B2B3B4), Sum(B1B2B3), Sum(B1B2B4), Sum(B1B3B4), Sum(B2B3B4), Avg(B1B2)B3, Avg(B1B2)B4, Avg(B1B3)B2, Avg(B1B3)B4, Avg(B1B4)B2, Avg(B1B4)B3, Avg(B2B3)B1, Avg(B2B3)B4, Avg(B2B4)B1, Avg(B2B4)B3, Avg(B3B4)B1, Avg(B3B4)B2) }

Fourth Selection

Select four different technical indicators from Group B and merged them by receiving the

average of four technical indicators or the summation of four technical indicators or average of three technical indicators added into other technical indicator or average of two technical indicators added into average of another two technical indicators. In other words, second selection merged with different technical indicator and obtained the summation or the average.

$n(B^4)$ = Select four different technical indicators from Group B either summation or average + Select four different technical indicators from Group B with summation and average

$$= 2 * C_{(4,\ 4)} + C_{(4,\ 3)} * C_{(1,\ 1)} + (\ C_{(4,\ 2)} * C_{(2,\ 2)}\ )/2$$

$$= 2 * \frac{4!}{4!\ 1!} + \frac{4!}{3!\ 1!} + \frac{4!}{2!\ 2!} = 2 + 4 + (\frac{3 * 4}{2})/2 = 7$$

$B^4 =$ { Avg(B1B2B3B4), Sum(B1B2B3B4), Avg(B1B2B3)B4, Avg(B1B2B4)B3, Avg(B1B3B4)B2, Avg(B2B3B4)B1, Avg(B1B2)Avg(B3B4), Avg(B1B3)Avg(B2B4), Avg(B1B4)Avg(B2B3) }

Finally obtained the results of B^1, B^2, B^3 and B^4.

Experiment 3 – How to combine Group A Technical Indicators with Group B Technical Indicators and Identify which combination is best.

A^{ALL} = All selections of Group A = { A^1, A^2, A^3, A^4, A^5, A^6, A^7 }

Step 0 :- Select one from selection from (A^{ALL}). For example, select A^7.

Step 1 :- Ignored possible(possible but already combined)/impossible combinations. (Almost done in Experiment 1)

Step 2 :- Select one from (A^7) = { A1A2A3A4A5A6A7 }

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

Step 4 :- Obtained results by merging A^7(A1A2A3A4A5A6A7) with B^1.

Step 5 :- Plotted a graph with obtained results.

Step 6 :- Identify the best combination of A^7(A1A2A3A4A5A6A7) merge with B^1 which means identify which combination demonstration the smallest difference between the closing price and the combination.

Step 7 :- Ignored possible(possible but already combined)/impossible combinations and obtained results by merging A^7(A1A2A3A4A5A6A7) with B^2

Step 8 :- Plotted a graph with obtained results.

Step 9 :- Identify the best combination of A^7(A1A2A3A4A5A6A7) merge with B^2 which means identify which combination demonstration the smallest difference the between closing price and the combination.

Step 10 :- Ignored possible(possible but already combined)/impossible combinations and obtained results by merging A^7(A1A2A3A4A5A6A7) with B^3

Step 11 :- Plotted a graph with obtained results.

Step 12 :- Identify the best combination of A^7(A1A2A3A4A5A6A7) merge with B^3 which means identify which combination demonstration the smallest difference the between closing price and the combination.

Step 13 :- Ignored possible(possible but already combined)/impossible combinations and obtained results by merging A^7(A1A2A3A4A5A6A7) with B^4

Step 14 :- Plotted a graph with obtained results.

Step 15 :- Identify the best combination of A^7(A1A2A3A4A5A6A7) merge with B^4 which means identify which combination demonstration the smallest difference the between closing price and the combination.

Step 16 :- Plotted best combinations obtained in Step 6, 9, 12 and 15.

Step 17 :- Identify the best combination of A^7(A1A2A3A4A5A6A7) merge with B^{ALL} which means identify which combination demonstration the smallest difference between closing price and the combination.

Step 18 :- Repeat Step 2 to Step 17 up until all the selection of A^7.

Step 19 :- Plotted all the best combinations obtained from Step 17.

Step 20 :- Identify the best combination of A^7 merge with B^{ALL} which means identify which combination demonstration the smallest difference between closing price and the combination.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Step 22 :- Plotted all the best combinations obtained from Step 20.

Step 23 :- Identify the best combination of A^{ALL} merge with B^{ALL} which means identify which combination demonstration the smallest difference between closing price and the combination.

For example,

      C = Closing Price

      P = {p_1, p_2, p_3}; p_1 is equal to p_3.   Q = {q_1, q_2, q_3}

      P^1 = select one from P = { p_1, p_2, p_3}

      P^2 = select two different from P = { (p_1p_2), (p_2p_3), (p_1p_3)}

      P^3 = select three different from P = { ($p_1p_2p_3$)}

      P^{ALL} =All selections of P = { P^1, P^2 } = { p_1, p_2, (p_1p_2) }

      Q^1 = select one from Q = { q_1, q_2, q_3}

Q^2 = select two different from Q = { sum(q_1q_2), sum(q_2q_3), sum(q_1q_3), avg(q_1q_2), avg(q_2q_3), avg(q_1q_3)}

Q^3 = select three different from Q = { sum($q_1q_2q_3$), avg($q_1q_2q_3$), sum(avg(q_1q_2)q_3), sum(avg(q_2q_3)q_1), sum(avg(q_1q_3)q_2) }

Q^{ALL} =All selections of Q = {Q^1, Q^2, Q^3 } = { q_1, q_2, q_3, sum(q_1q_2), sum(q_2q_3), sum(q_1q_3), avg(q_1q_2), avg(q_2q_3), avg(q_1q_3), sum($q_1q_2q_3$), avg($q_1q_2q_3$), sum(avg(q_1q_2)q_3), sum(avg(q_2q_3)q_1), sum(avg(q_1q_3)q_2) }

Identify the best combination of P^{ALL} with Q^{ALL}

To identify the best combination of P^{ALL} with Q^{ALL}, have to identify the best combination of P^1 with Q^{ALL}, P^2 with Q^{ALL} and P^3 with Q^{ALL} separately.

Identify the best combination of P^1 with Q^{ALL}

To identify the best combination of P^1 with Q^{ALL}, have to identify the best combination of $P^1(p_1)$ with Q^{ALL} and $P^1(p_2)$ with Q^{ALL} separately.

<u>Identify the best combination of $P^1(p_1)$ with Q^{ALL}</u>

Assume:- | p_1q_1 – C | > | p_1q_2 – C | > | p_1q_3 – C | > | p_1 sum(q_1q_2) – C | > | p_1 sum(q_2q_3) – C | > | p_1 sum(q_1q_3) – C | > | p_1 avg(q_1q_2) – C | > | p_1 avg(q_2q_3) – C | > | p_1 avg(q_1q_3) – C | > | p_1 sum($q_1q_2q_3$) – C | > | p_1 avg($q_1q_2q_3$) – C | > | p_1 sum(avg(q_1q_2)q_3) – C | > | p_1 sum(avg(q_2q_3)q_1) – C | > | p_1 sum(avg(q_1q_3)q_2) – C |

Conclusion:- best combination of $P^1(p_1)$ with Q^{ALL} is p_1 sum(avg(q_1q_3)q_2)

(because | p_1 sum(avg(q_1q_3)q_2) – C| is smaller than the other combinations)

<u>Identify the best combination of $P^1(p_2)$ with Q^{ALL}</u>

Assume:- | p_2q_1 – C | < | p_2q_2 – C | < | p_2q_3 – C | < | p_2 sum(q_1q_2) – C | < | p_2 sum(q_2q_3) – C | < | p_2 sum(q_1q_3) – C | < | p_2 avg(q_1q_2) – C | < | p_2 avg(q_2q_3) – C | < | p_2 avg(q_1q_3) – C | < | p_2 sum($q_1q_2q_3$) – C | < | p_2 avg($q_1q_2q_3$) – C | < | p_2 sum(avg(q_1q_2)q_3) – C | < | p_2 sum(avg(q_2q_3)q_1) – C | < | p_2 sum(avg(q_1q_3)q_2) – C |

Conclusion:- best combination of $P^1(p_2)$ with Q^{ALL} is p_2q_1

(because $| p_2q_1 - C |$ is smaller than the other combinations)

Identify the best combination of $P^1(p_3)$ with Q^{ALL}

$p_1 = p_3$; Identify the best combination of $P^1(p_1)$ with Q^{ALL} is almost done.

Therefore, ignored these combinations.

After identifying p_1 sum(avg(q_1q_3)q_2), p_2q_1 are the best combination of $P^1(p_1)$ with Q^{ALL}, $P^1(p_2)$ with Q^{ALL} and $P^1(p_3)$ with Q^{ALL} separately, can identify the best combination of P^1 with Q^{ALL}.

Assume:- $| p_1$ sum(avg(q_1q_3)q_2) $- C | < | p_2q_1 - C |$

Conclusion:- best combination of P^1 with Q^{ALL} is p_1 sum(avg(q_1q_3)q_2)

(because $| p_1$ sum(avg(q_1q_3)q_2) $- C |$ is smaller than $| p_2q_1 - C |$)

Identify the best combination of P^2 with Q^{ALL}

To identify the best combination of P^2 with Q^{ALL}, have to identify the best combination of $P^2(p_1p_2)$ with Q^{ALL}, $P^2(p_2p_3)$ with Q^{ALL} and $P^2(p_1p3)$ with Q^{ALL} separately.

Identify the best combination of $P^2(p_1p_2)$ with Q^{ALL}

Assume:- $| (p_1p_2)q_1 - C | > | (p_1p_2)q_2 - C | > | (p_1p_2)q_3 - C | > | (p_1p_2)$ sum(q_1q_2) $- C | > | (p_1p_2)$ sum(q_2q_3) $- C | > | (p_1p_2)$ sum(q_1q_3) $- C | > | (p_1p_2)$ avg(q_1q_2) $- C | > | (p_1p_2)$ avg(q_2q_3) $- C | > | (p_1p_2)$ avg(q_1q_3) $- C | > | (p_1p_2)$ sum($q_1q_2q_3$) $- C | > | (p_1p_2)$ avg($q_1q_2q_3$) $- C | > | (p_1p_2)$ sum(avg(q_1q_2)q_3) $- C | > | (p_1p_2)$ sum(avg(q_2q_3)q_1) $- C | > | (p_1p_2)$ sum(avg(q_1q_3)q_2) $- C |$

Conclusion:- best combination of $P^2(p_1p_2)$ with Q^{ALL} is (p_1p_2) sum(avg(q_1q_3)q_2)

(because $| (p_1p_2)$ sum(avg(q_1q_3)q_2) $- C|$ is smaller than the other combinations)

Identify the best combination of $P^2(p_2p_3)$ with Q^{ALL}

avg(p_1p_2)=avg(p_2p_3)   (because $p_{1 = p_3}$)

Identify the best combination of $P^2(p_1p_2)$ with Q^{ALL} is almost done.

Therefore, ignored these combinations.

Identify the best combination of $P^2(p_1p_3)$ with Q^{ALL}

avg(p_1p_3) = p_1 = p_3

Identify the best combination of $P^1(p_1)$ with Q^{ALL} is almost done.

Therefore, ignored these combinations.

After identifying (p_1p_2) sum(avg$(q_1q_3)q_2$) is the best combination of $P^2(p_1p_2)$ with Q^{ALL} can identify best the combination of P^2 with Q^{ALL}.

Conclusion:- best combination of P^2 with Q^{ALL} is (p_1p_2) sum(avg$(q_1q_3)q_2$)

(because P^2 has only one possibility)

Identify the best combination of P^3 with Q^{ALL}

Identify the best combination of $P^3(p_1p_2p_3)$ with Q^{ALL}

Assume:- $|$ $(p_1p_2p_3)q_1 - C$ $|$ $>$ $|$ $(p_1p_2p_3)q_2 - C$ $|$ $>$ $|$ $(p_1p_2p_3)q_3 - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum$(q_1q_2) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum$(q_2q_3) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum$(q_1q_3) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ avg$(q_1q_2) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ avg$(q_2q_3) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ avg$(q_1q_3) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum$(q_1q_2q_3) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ avg$(q_1q_2q_3) - C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum(avg$(q_1q_2)q_3$) $- C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum(avg$(q_2q_3)q_1$) $- C$ $|$ $>$ $|$ $(p_1p_2p_3)$ sum(avg$(q_1q_3)q_2$) $- C|$

Conclusion:- best combination of $P^1(p_1p_2p_3)$ with Q^{ALL} is $(p_1p_2p_3)$ sum(avg$(q_1q_3)q_2$)

(because $|$ $(p_1p_2p_3)$ sum(avg$(q_1q_3)q_2$) $- C|$ is smaller than the other combinations)

After identifying p_1 sum(avg$(q_1q_3)q_2$), (p_1p_2) sum(avg$(q_1q_3)q_2$) and $(p_1p_2p_3)$ sum(avg$(q_1q_3)q_2$) are the best combination of P^1 with Q^{ALL}, P^2 with Q^{ALL} and P^3 with Q^{ALL} separately, can identify the best combination of P^{ALL} with Q^{ALL}.

Assume:- $|$ p_1 sum(avg$(q_1q_3)q_2$) $- C$ $|$ $>$ $|$ (p_1p_2) sum(avg$(q_1q_3)q_2$) $- C$ $|$ $<$ $|$ $(p_1p_2p_3)$ sum(avg$(q_1q_3)q_2$) $- C|$

Conclusion:- best combination of P^{ALL} with Q^{ALL} is (p_1p_2) sum(avg$(q_1q_3)q_2$)

(because $|$ (p_1p_2) sum(avg$(q_1q_3)q_2$) $- C|$ is smaller than $|$ p_1 sum(avg$(q_1q_3)q_2$) $- C$ $|$)

Therefore, the proposed Experiment 3 is a valid solution to identify the best combination of Group A with Group B.

<u>Experiment 4 –Identify which combination is best from obtained results from Experiment 1 and Experiment 3</u>

To identify the best combination from the results obtained from Experiment 1 and Experiment 3, plotted a graph with the best combinations obtained from Experiment 1 and Experiment 3 and identify the best combination which means identify which combination demonstration the smallest difference between the closing price and the combination.

For Example,

According to the example mentioned in Experiment 1 obtained the best combination as p_1p_2 which is the best combination of P^{ALL}. As said by example in Experiment 3 obtained the best combination as (p_1p_2) sum(avg(q_1q_3)q_2) which is the best combination of P^{ALL} with Q^{ALL}.

Assume:- $| p_1p_2 - C | > | (p_1p_2)$ sum(avg(q_1q_3)q_2) $- C |$

Conclusion:- best combination of P^{ALL} and P^{ALL} with Q^{ALL} is (p_1p_2) sum(avg(q_1q_3)q_2)

(because $| (p_1p_2)$ sum(avg(q_1q_3)q_2) $- C|$ is smaller than $| p_1p_2 - C |$)

Therefore, the proposed Experiment 4 is a valid solution to identify the best combination of Group A and Group A with Group B.

4.3. Summary

This chapter provided the proposed solution of this research which was how to obtain the best combination of technical indicators to predict stock price by analyzing the results of individual and combination of technical indicators by using the selected dataset.

Chapter 5.   Evaluation

5.1. Introduction

This chapter provides the evaluation of the results obtained from the graphical view of the individual and combination of technical indicators. By using these graphical views get the best combination of technical indicators to predict the stock price.

5.2. Evaluation of the Results

5.2.1. Experiment 1

To identify the best combination of A^{ALL}, go through those identified combinations in Experiment 1 under the section 4.2.2 Analysis of Combination of Technical Indicators with the data set as follow.

A^{ALL} = All selections of Group A = { $A^1, A^2, A^3, A^4, A^5, A^6, A^7$ }

Experiment 1.1. A^1

Step 0:- Select one from (A^{ALL}) = { A^1 }

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- 20-days SMA is equal to 20-days BB. Therefore, ignored A2 (Bollinger Band).
- RSI is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored A7(RSI).

Step 2 :- Obtained results of A^1 which means obtained the results by selecting individual technical indicator from Group A is illustrated in Figure 5. 1.

Step 3 :- Plotted graph with obtained results is demonstrated in Figure 5. 2.

Date	Closing (Rs.)	SMA	14-days EMA	UB	LB	AveragePrice
2-Jan-02	58.00	0	0	0	0	58.87
3-Jan-02	57.75	0	0	0	0	57.45
4-Jan-02	56.25	0	0	0	0	56.95
7-Jan-02	55.00	0	0	0	0	56.03
8-Jan-02	55.00	0	0	0	0	55.53
9-Jan-02	55.00	0	0	0	0	55.53
10-Jan-02	54.00	0	0	0	0	54.53
11-Jan-02	52.75	0	0	0	0	53.28
15-Jan-02	50.25	0	0	0	0	50.28
16-Jan-02	49.50	0	0	0	0	50.03
17-Jan-02	48.00	0	0	0	0	48.78
18-Jan-02	50.25	0	0	0	0	49.70
21-Jan-02	50.25	0	0	0	0	50.45
22-Jan-02	50.00	53	53	54.60356745	51.39643255	50.28
23-Jan-02	48.75	52.3392857	52.43333333	54.25783963	50.4207318	49.28
24-Jan-02	52.50	51.9642857	52.44222222	52.25063704	51.67793438	51.45
25-Jan-02	52.00	51.6607143	52.38325926	51.84207013	51.47935844	52.37
29-Jan-02	52.00	51.4464286	52.33215802	51.74232495	51.1505322	52.03
30-Jan-02	51.50	51.1964286	52.22120362	51.35869433	51.03416282	51.87
31-Jan-02	50.50	50.875	51.99170981	51.07544593	50.67455407	50.95
1-Feb-02	52.00	50.7321429	51.99281516	51.40984101	50.05444471	51.78
5-Feb-02	52.00	50.6785714	51.99377314	51.38490471	49.97223815	52.37
6-Feb-02	52.00	50.8035714	51.99460339	51.4430894	50.16405346	52.20
7-Feb-02	50.00	50.8392857	51.72865627	51.2879028	50.39066863	50.95
8-Feb-02	48.25	50.8571429	51.26483544	52.25071933	49.46356638	48.95
11-Feb-02	49.00	50.7678571	50.96285738	51.71281653	49.82289775	48.95
12-Feb-02	49.50	50.7142857	50.76780973	51.36334873	50.0652227	49.87

Figure 5. 1: Calculations of A^1
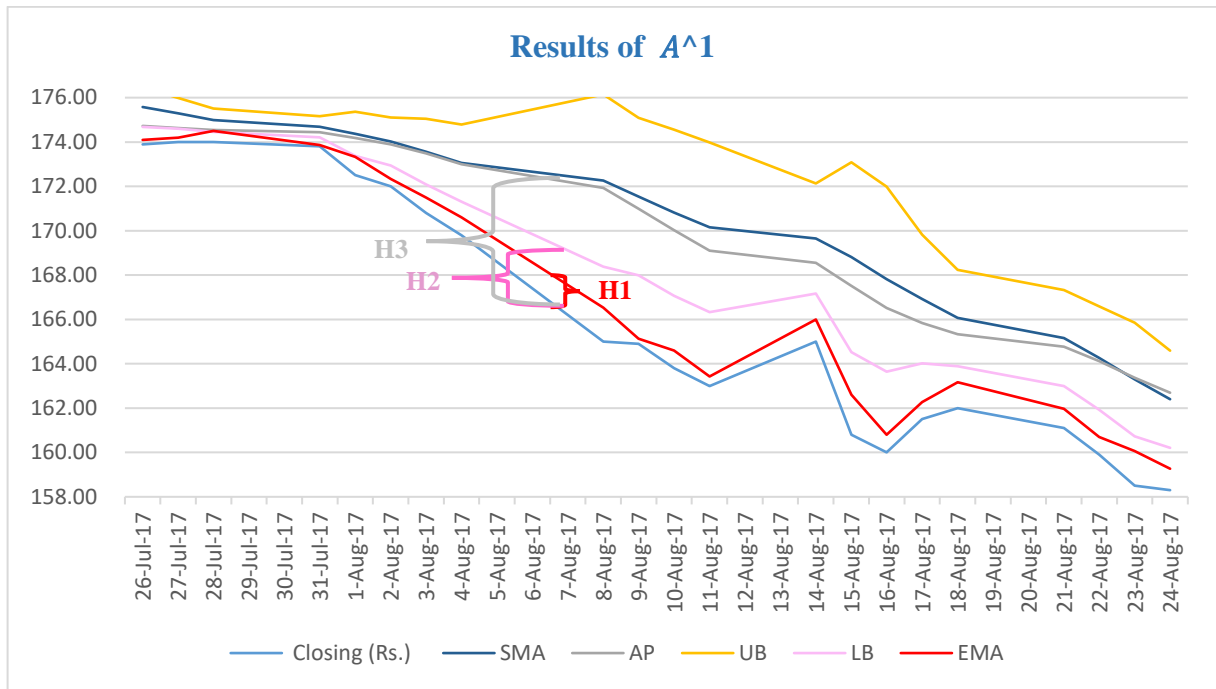
Figure 5. 2: Results of A[1]

Step 4 :- From the Figure 5. 2 can identify,

      H1 – Difference between EMA and the closing price

      H2 – Difference between LB and the closing price

      H3 – Difference between AP and the closing price

$$H1 < H2 < H3 < \ldots \ldots$$

Therefore, the best combination of A^1 which means identify which technical indicator demonstration the smallest difference between the closing price and the technical indicator as EMA.

Step 5 :- Repeat Step 0 to Step 3.

Experiment 1.2. A^2

Step 0 :- Select two different technical indicators from $(A^{ALL}) = \{ A^2 \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- A1 is 20-days SMA and A2 is 20-days BB. Therefore A1=A2.

  $Avg(A1A2) = \frac{BB+SMA}{2}$ = SMA or BB

  It almost analysed in section Experiment 1.1. A[1].

  Therefore, ignored A1A2 combination.

- A1(SMA) is equal to A2(BB)

  A1A3, A1A4, A1A5, A1A6, A1A7 almost combined.

  Therefore, ignored A2A3, A2A4, A2A5, A2A6, A2A7 combinations.

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- A3 (UB) is 2 standard deviation above the BB.

    A4 (LB) is 2 standard deviation below the BB.

    $$\text{Avg(A3A4)} = \frac{(BB+2*Std)+(BB-2*Std)}{2} = BB$$

    It almost analysed in section Experiment 1.1. A[1].

    Therefore, ignored A3A4 combination.

- A7(RSI) is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored A1A7, A2A7, A3A7, A4A7, A5A7 and A6A7.

- Since EMA is the best individual technical indicator according to Figure 5. 2, combining A1A2, A1A3, A1A4, A1A5, A1A7, A2A3, A2A4, A2A5, A2A7, A3A4, A3A5, A3A7, A4A5, , A4A7, A5A7 can be eliminated.

Step 2 :- Obtained results of A^2 which means obtained the results by merging two different technical indicators from Group A is shown in Figure 5. 3.

Step 3 :- Plotted graph with obtained results is demonstrated in Figure 5. 4.

Closing (Rs.)	Avg(SMA, UB)	Avg(SMA, LB)	Avg(SMA, AP)	Avg(SMA, EMA)	Avg(UB, AP)	Avg(UB, EMA)	Avg(LB, AP)	Avg(LB, EMA)	Avg(AP, EMA)
58.00	-	-	29.33	-	29.33	-	29.33	-	29.33
57.75	-	-	28.63	-	28.63	-	28.63	-	28.63
56.25	-	-	28.38	-	28.38	-	28.38	-	28.38
55.00	-	-	27.92	-	27.92	-	27.92	-	27.92
55.00	-	-	27.67	-	27.67	-	27.67	-	27.67
55.00	-	-	27.67	-	27.67	-	27.67	-	27.67
54.00	-	-	27.17	-	27.17	-	27.17	-	27.17
52.75	-	-	26.54	-	26.54	-	26.54	-	26.54
50.25	-	-	25.04	-	25.04	-	25.04	-	25.04
49.50	-	-	24.92	-	24.92	-	24.92	-	24.92
48.00	-	-	24.29	-	24.29	-	24.29	-	24.29
50.25	-	-	24.75	-	24.75	-	24.75	-	24.75
50.25	-	-	25.13	-	25.13	-	25.13	-	25.13
50.00	53.80	52.20	51.54	53.00	52.34	53.80	50.74	52.20	51.54
48.75	53.30	51.38	50.71	52.39	51.67	53.35	49.75	51.43	50.76
52.50	52.11	51.82	51.61	52.20	51.75	52.35	51.46	52.06	51.85
52.00	51.75	51.57	51.91	52.02	52.00	52.11	51.82	51.93	52.27
52.00	51.59	51.30	51.64	51.89	51.79	52.04	51.49	51.74	52.08
51.50	51.28	51.12	51.43	51.71	51.51	51.79	51.35	51.63	51.94
50.50	50.98	50.77	50.81	51.43	50.91	51.53	50.71	51.33	51.37
52.00	51.07	50.39	51.16	51.36	51.50	51.70	50.82	51.02	51.79

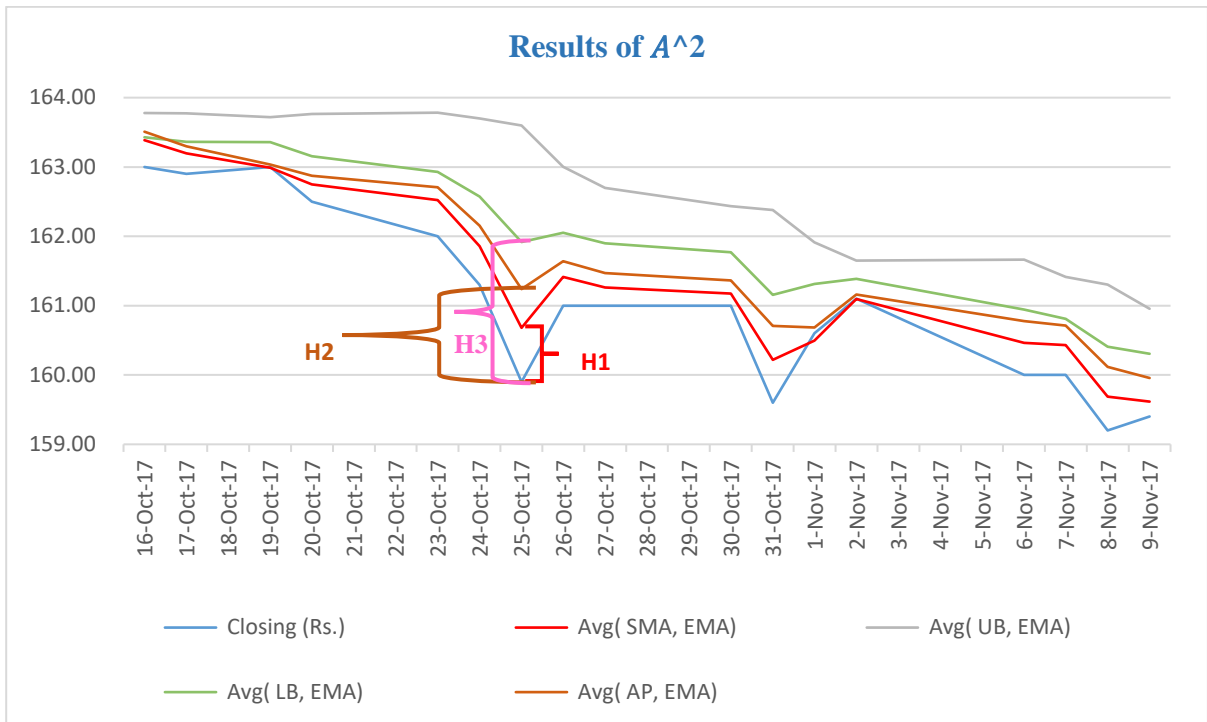Figure 5. 3: Calculations of A²

Figure 5. 4: Results of A^2

Step 4 :- From the Figure 5. 4 can identify,

> H1 – Difference between Avg(SMA, EMA) and the closing price
>
> H2 – Difference between Avg(AP, EMA) and the closing price
>
> H3 – Difference between Avg(LB, EMA) and the closing price
>
> $$H1 < H2 < H3 < \ldots\ldots.$$

Therefore, the best combination of A^2 which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg (SMA, EMA).

Step 5 :- Repeat Step 0 to Step 3.

Experiment 1.3. A^3

Step 0 :- Select three different technical indicators from $(A^{ALL}) = \{ A^3 \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- A1(SMA) is equal to A2(BB)

  A1A3A4, A1A3A5, A1A3A6, A1A3A7, A1A4A5, A1A4A6, A1A4A7, A1A5A6, A1A5A7, A1A6A7 almost combined.

  Therefore, ignored A2A3A4, A2A3A5, A2A3A6, A2A3A7, A2A4A5, A2A4A6, A2A4A7, A2A5A6, A2A5A7, A2A6A7 combinations.

- A3 (UB) is 2 standard deviation above the BB.

  A4 (LB) is 2 standard deviation below the BB.

$$\text{Avg(A1A3A4)} = \text{Avg(A2A3A4)} = \frac{BB + (BB + 2*Std) + (BB - 2*Std)}{3} = \text{BB}$$

It almost analysed in section Experiment 1.1. A[1].

Therefore, ignored A1A3A4 combination.

- A7(RSI) is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored A1A2A7, A1A3A7, A1A4A7, A1A5A7, A1A6A7, A2A3A7, A2A4A7, A2A5A7, A2A6A7, A3A4A7, A3A5A7, A3A6A7, A4A5A7, A4A6A7, A5A6A7 combinations.

- Since Avg(EMA, SMA) is the best combination of technical indicators according to Figure 5. 4, combining A1A2A3, A1A2A4, A1A2A5, A1A2A7, A1A3A4, A1A3A5, A1A3A7, A1A4A5, A1A4A7, A1A5A7, A2A3A4, A2A3A5, A2A3A7, A2A4A5, A2A4A7, A2A5A7, A3A4A5, A3A4A6, A3A4A7, A3A5A6, A3A5A7, A3A6A7, A4A5A6, A4A5A7, A4A6A7, A5A6A7can be eliminated.

Step 2 :- Obtained results of A^3 which means obtained the results by merging three different technical indicators from Group A is illustrated in Figure 5. 5.

Step 3 :- Plotted graph with obtained results is demonstrated in Figure 5. 6.

| Date	Closing (Rs.)	Avg(SMA, BB, UB)	Avg(SMA, BB, LB)	Avg(SMA, BB, AP)	Avg(SMA, BB, EMA)	Avg(SMA, UB, AP)	Avg(SMA, UB, EMA)	Avg(SMA, LB, AP)	Avg(SMA, LB, EMA)	Avg(SMA, AP, EMA)	Avg(UB, LB, AP)	Avg(UB, LB, EMA)	Avg(UB, AP, EMA)	Avg(LB, AP, EMA)
2-Jan-02	58.00	-	-	19.56	-	19.56	-	19.56	-	19.56	19.56	0	19.56	19.56
3-Jan-02	57.75	-	-	19.08	-	19.08	-	19.08	-	19.08	19.08	0	19.08	19.08
4-Jan-02	56.25	-	-	18.92	-	18.92	-	18.92	-	18.92	18.92	0	18.92	18.92
7-Jan-02	55.00	-	-	18.61	-	18.61	-	18.61	-	18.61	18.61	0	18.61	18.61
8-Jan-02	55.00	-	-	18.44	-	18.44	-	18.44	-	18.44	18.44	0	18.44	18.44
9-Jan-02	55.00	-	-	18.44	-	18.44	-	18.44	-	18.44	18.44	0	18.44	18.44
10-Jan-02	54.00	-	-	18.11	-	18.11	-	18.11	-	18.11	18.11	0	18.11	18.11
11-Jan-02	52.75	-	-	17.69	-	17.69	-	17.69	-	17.69	17.69	0	17.69	17.69
15-Jan-02	50.25	-	-	16.69	-	16.69	-	16.69	-	16.69	16.69	0	16.69	16.69
16-Jan-02	49.50	-	-	16.61	-	16.61	-	16.61	-	16.61	16.61	0	16.61	16.61
17-Jan-02	48.00	-	-	16.19	-	16.19	-	16.19	-	16.19	16.19	0	16.19	16.19
18-Jan-02	50.25	-	-	16.50	-	16.50	-	16.50	-	16.50	16.50	0	16.50	16.50
21-Jan-02	50.25	-	-	16.75	-	16.75	-	16.75	-	16.75	16.75	0	16.75	16.75
22-Jan-02	50.00	53.53	52.47	52.03	53.00	52.56	53.53	51.49	52.47	52.03	52.03	53	52.56	51.49
23-Jan-02	48.75	52.98	51.70	51.25	52.37	51.89	53.01	50.61	51.73	51.29	51.25	52.3706	51.92	50.65
24-Jan-02	52.50	52.06	51.87	51.73	52.12	51.82	52.22	51.63	52.03	51.89	51.73	52.1236	51.98	51.79
25-Jan-02	52.00	51.72	51.60	51.83	51.90	51.89	51.96	51.77	51.84	52.07	51.83	51.9016	52.13	52.01
29-Jan-02	52.00	51.55	51.35	51.58	51.74	51.67	51.84	51.48	51.64	51.87	51.58	51.7417	51.97	51.77
30-Jan-02	51.50	51.25	51.14	51.35	51.54	51.41	51.59	51.30	51.48	51.69	51.35	51.538	51.75	51.64
31-Jan-02	50.50	50.94	50.81	50.83	51.25	50.90	51.31	50.77	51.18	51.21	50.83	51.2472	51.27	51.14
1-Feb-02	52.00	50.96	50.51	51.02	51.15	51.24	51.38	50.79	50.93	51.44	51.02	51.1524	51.66	51.21
5-Feb-02	52.00	50.91	50.44	51.17	51.12	51.41	51.35	50.94	50.88	51.61	51.17	51.117	51.85	51.38
6-Feb-02	52.00	51.02	50.59	51.20	51.20	51.42	51.41	50.99	50.99	51.60	51.20	51.2006	51.81	51.39
7-Feb-02	50.00	50.99	50.69	50.81	51.14	50.96	51.29	50.66	50.99	51.11	50.81	51.1357	51.26	50.96

Figure 5. 5: Calculations of A^3
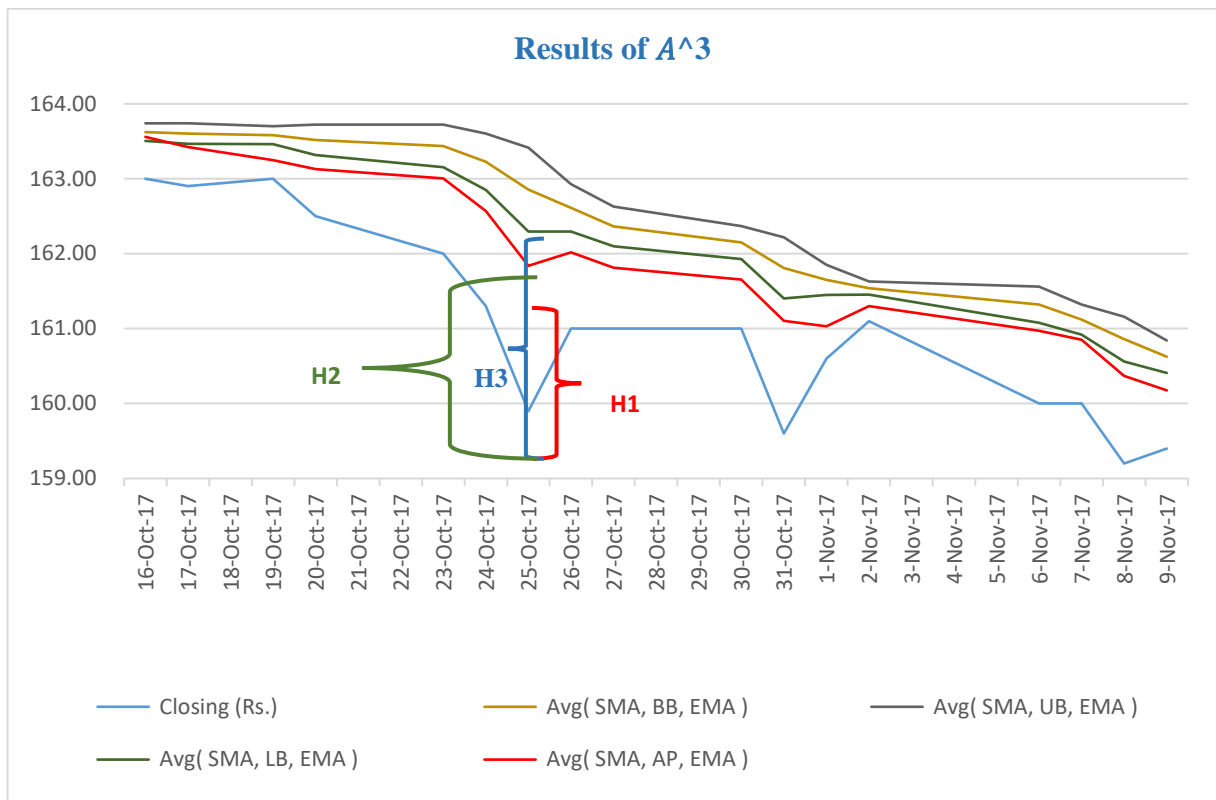
Figure 5. 6: Results of A³

Step 4 :- From the Figure 5. 6 can identify,

        H1 – Difference between Avg(SMA, AP, EMA) and the closing price

        H2 – Difference between Avg(SMA, LB, EMA) and the closing price

        H3 – Difference between Avg(SMA, BB, EMA) and the closing price

                H1 < H2 < H3 < …….

Therefore, the best combination of A^3 which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg (SMA, AP, EMA)

Step 5 :- Repeat Step 0 to Step 3.

Experiment 1.4. A^4

Step 0 :- Select four different technical indicators from $(A^{ALL}) = \{ A^4 \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- A1(SMA) is equal to A2(BB)

        A1A3A4A5, A1A3A4A6, A1A3A4A7, A1A3A5A6, A1A3A5A7, A1A3A6A7, A1A4A5A6, A1A4A5A7, A1A4A6A7, A1A5A6A7 almost combined.

        Therefore, ignored A2A3A4A5, A2A3A4A6, A2A3A4A7, A2A3A5A6, A2A3A5A7, A2A3A6A7, A2A4A5A6, A2A4A5A7, A2A4A6A7, A2A5A6A7 combinations.

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- A1(SMA) is equal to A2(BB)

  A3 (UB) is 2 standard deviation above the BB.

  A4 (LB) is 2 standard deviation below the BB.

  $$\text{Avg(A3A4A5A6)} = \frac{(BB + 2*Std) + (BB - 2*Std) + AP + EMA}{4}$$

  $$= \frac{BB + BB + AP + EMA}{4} = \text{Avg(A1A2A5A6)}$$

  $$\text{Avg(A3A4A5A7)} = \frac{(BB + 2*Std) + (BB - 2*Std) + AP + RSI}{4}$$

  $$= \frac{BB + BB + AP + RSI}{4} = \text{Avg(A1A2A5A7)}$$

  $$\text{Avg(A3A4A6A7)} = \frac{(BB + 2*Std) + (BB - 2*Std) + EMA + RSI}{4}$$

  $$= \frac{BB + BB + EMA + RSI}{4} = \text{Avg(A1A2A6A7)}$$

  A1A2A5A6, A1A2A5A7, A1A2A6A7 almost combined.

  Therefore, ignored A3A4A5A6, A3A4A5A7, A3A4A6A7 combinations.

- A1(SMA) is equal to A2(BB)

  A3 (UB) is 2 standard deviation above the BB.

  A4 (LB) is 2 standard deviation below the BB.

  $$\text{Avg(A1A2A3A4)} = \frac{(SMA + BB + (BB + 2*Std) + (BB - 2*Std)}{2} = \text{BB}$$

  It almost analysed in section Experiment 1.1. A[1].

  Therefore, ignored A1A2A3A4 combination.

- A7(RSI) is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored A1A2A3A7, A1A2A4A7, A1A2A5A7, A1A2A6A7, A1A3A4A7, A1A3A5A7, A1A3A6A7, A1A4A5A7, A1A4A6A7, A1A5A6A7, A2A3A4A7, A2A3A5A7, A2A3A6A7, A2A4A5A7, A2A4A6A7, A2A5A6A7, A3A4A5A7, A3A4A6A7, A3A5A6A7, A4A5A6A7 combinations.

- Since Avg (SMA, AP, EMA) is the best combination of technical indicators according to Figure 5. 6, combining A1A2A3A4, A1A2A3A5, A1A2A3A6, A1A2A3A7, A1A2A4A5, A1A2A4A6, A1A2A4A7, , A1A2A5A7, A1A2A6A7, A1A3A4A5, A1A3A4A6, A1A3A4A7, A1A3A5A7, A1A3A6A7, A1A4A5A7, A1A4A6A7, A2A3A4A5, A2A3A4A6, A2A3A4A7, A2A3A5A7, A2A3A6A7, A2A4A5A7, A2A4A6A7, , A3A4A5A6, A3A4A5A7, A3A4A6A7, A3A5A6A7, A4A5A6A7 can be eliminated.

Step 2 :- Obtained results of A^4 which means obtained the results by merging four different technical indicators from Group A is illustrated in Figure 5. 7.

Step 3 :- Plotted graph with obtained results is demonstrated in Figure 5. 8.

| Date	Closing (Rs.)	Avg(SMA, BB, UB, AP)	Avg(SMA, BB, UB, EMA)	Avg(SMA, BB, UB, RSI)	Avg(SMA, BB, LB, AP)	Avg(SMA, BB, LB, EMA)	Avg(SMA, BB, AP, EMA)	Avg(SMA, UB, LB, AP)	Avg(SMA, UB, LB, EMA)	Avg(SMA, UB, AP, EMA)	Avg(SMA, LB, AP, EMA)	Avg(SMA, LB AP, EMA)
2-Jan-02	58.00	14.67	–	–	14.67	–	14.67	14.67	–	14.67	14.67	14.67
3-Jan-02	57.75	14.31	–	–	14.31	–	14.31	14.31	–	14.31	14.31	14.31
4-Jan-02	56.25	14.19	–	–	14.19	–	14.19	14.19	–	14.19	14.19	14.19
7-Jan-02	55.00	13.96	–	–	13.96	–	13.96	13.96	–	13.96	13.96	13.96
8-Jan-02	55.00	13.83	–	–	13.83	–	13.83	13.83	–	13.83	13.83	13.83
9-Jan-02	55.00	13.83	–	–	13.83	–	13.83	13.83	–	13.83	13.83	13.83
10-Jan-02	54.00	13.58	–	–	13.58	–	13.58	13.58	–	13.58	13.58	13.58
11-Jan-02	52.75	13.27	–	–	13.27	–	13.27	13.27	–	13.27	13.27	13.27
15-Jan-02	50.25	12.52	–	–	12.52	–	12.52	12.52	–	12.52	12.52	12.52
16-Jan-02	49.50	12.46	–	–	12.46	–	12.46	12.46	–	12.46	12.46	12.46
17-Jan-02	48.00	12.15	–	–	12.15	–	12.15	12.15	–	12.15	12.15	12.15
18-Jan-02	50.25	12.38	–	–	12.38	–	12.38	12.38	–	12.38	12.38	12.38
21-Jan-02	50.25	12.56	–	–	12.56	–	12.56	12.56	–	12.56	12.56	12.56
22-Jan-02	50.00	52.67	53.40	44.24	51.87	52.60	52.27	52.27	53.00	52.67	51.87	51.87
23-Jan-02	48.75	52.00	52.84	48.43	51.05	51.88	51.55	51.53	52.36	52.03	51.07	51.07
24-Jan-02	52.50	51.86	52.16	48.28	51.71	52.01	51.91	51.79	52.08	51.98	51.83	51.83
25-Jan-02	52.00	51.83	51.89	48.79	51.74	51.80	51.97	51.79	51.84	52.01	51.92	51.92
29-Jan-02	52.00	51.62	51.74	48.34	51.47	51.59	51.76	51.54	51.67	51.84	51.69	51.69
30-Jan-02	51.50	51.35	51.49	47.53	51.27	51.41	51.57	51.31	51.45	51.61	51.53	51.53
31-Jan-02	50.50	50.89	51.20	49.24	50.79	51.10	51.12	50.84	51.15	51.17	51.07	51.07

Figure 5. 7: Calculations of A^4
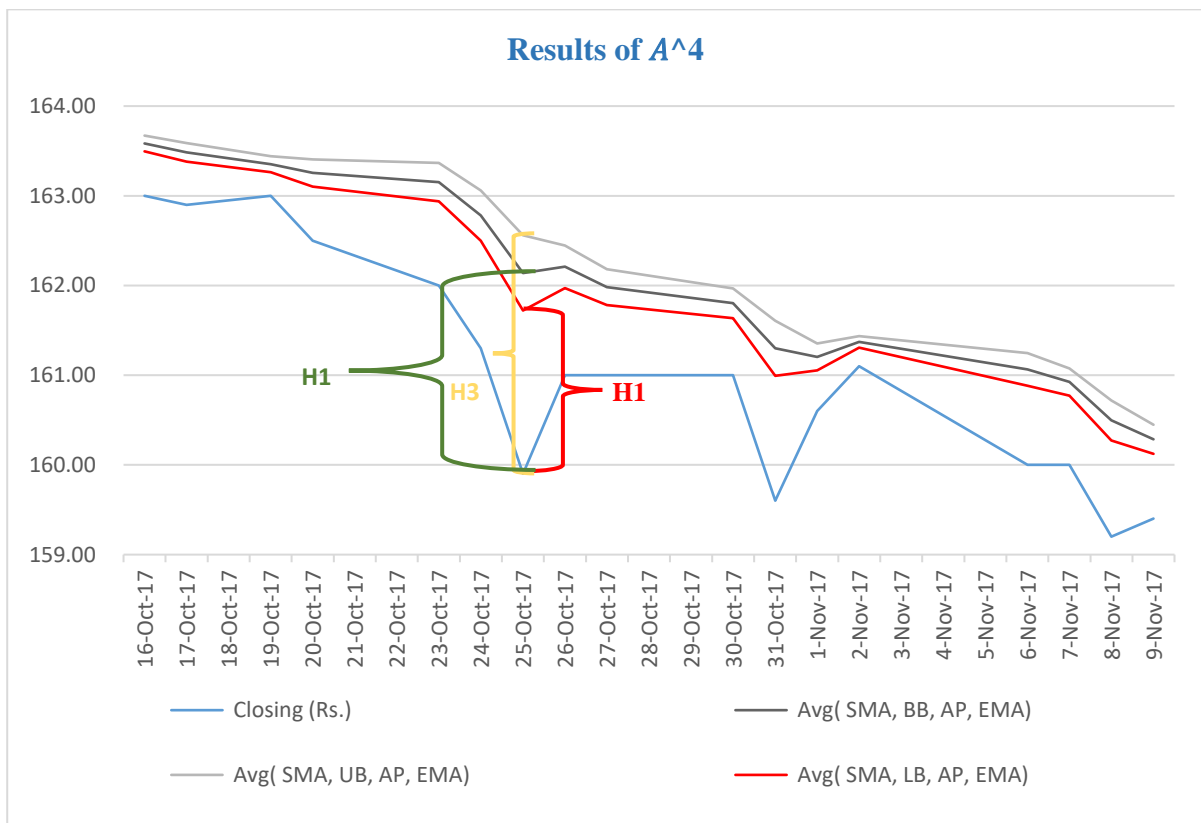
Figure 5. 8: Results of A^4

Step 4 :- From the Figure 5. 8 can identify,

H1 – Difference between Avg(SMA, LB, AP, EMA) and the closing price

H2 – Difference between Avg(SMA, BB, AP, EMA) and the closing price

H3 – Difference between Avg(SMA, UB, AP, EMA) and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^4 which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg (SMA, LB, AP, EMA).

Step 5 :- Repeat Step 0 to Step 3.

Experiment 1.5. A^5

Step 0 :- Select five different technical indicators from (A^{ALL}) = { A^5 }

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- A1(SMA) is equal to A2(BB)

   A1A3A4A5A6,   A1A3A4A5A7,   A1A3A4A6A7,   A1A3A5A6A7, A1A4A5A6A7 almost combined.

   Therefore,   ignored   A2A3A4A5A6,   A2A3A4A5A7,   A2A3A4A6A7, A2A3A5A6A7, A2A4A5A6A7 combinations.

- A7(RSI) is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for   the   stock.   Therefore,   ignored   A1A2A3A4A7,   A1A2A3A5A7, A1A2A3A6A7,   A1A2A4A5A7,   A1A2A4A6A7,   A1A2A5A6A7, A1A3A4A5A7,   A1A3A4A6A7,   A1A3A5A6A7,A1A4A5A6A7, A2A3A4A5A7,   A2A3A4A6A7,   A2A3A5A6A7,   A2A4A5A6A7, A3A4A5A6A7 combinations.

- Since Avg(SMA, LB, AP, EMA) is the best combination of technical indicators according   to   Figure   5. 8,   combining   A1A2A3A4A5,   A1A2A3A4A6, A1A2A3A4A7,   A1A2A3A5A6,   A1A2A3A5A7,   A1A2A3A6A7, A1A2A4A5A7,   A1A2A4A6A7,   A1A2A5A6A7,   A1A3A4A5A7, A1A3A4A6A7,   A1A3A5A6A7,   A2A3A4A5A7,   A2A3A4A6A7, A2A3A5A6A7, A3A4A5A6A7 can be eliminated.

Step 2 :- Obtained results of A^5 which means obtained the results by merging five different technical indicators from Group A is illustrated in Figure 5. 9.

Step 3 :- Plotted graph with obtained results is demonstrated in Figure 5. 10.

| Date	Closing (Rs.)	Avg (SMA+BB +UB + LB +AP)	SMA+BB +UB + LB +EMA)	Avg (SMA+BB +UB +AP +EMA)	Avg (SMA+BB + LB +AP +EMA)	Avg (SMA+UB + LB +AP +EMA)
2-Jan-02	58.00	11.73	-	11.73	11.73	11.73
3-Jan-02	57.75	11.45	-	11.45	11.45	11.45
4-Jan-02	56.25	11.35	-	11.35	11.35	11.35
7-Jan-02	55.00	11.17	-	11.17	11.17	11.17
8-Jan-02	55.00	11.07	-	11.07	11.07	11.07
9-Jan-02	55.00	11.07	-	11.07	11.07	11.07
10-Jan-02	54.00	10.87	-	10.87	10.87	10.87
11-Jan-02	52.75	10.62	-	10.62	10.62	10.62
15-Jan-02	50.25	10.02	-	10.02	10.02	10.02
16-Jan-02	49.50	9.97	-	9.97	9.97	9.97
17-Jan-02	48.00	9.72	-	9.72	9.72	9.72
18-Jan-02	50.25	9.90	-	9.90	9.90	9.90
21-Jan-02	50.25	10.05	-	10.05	10.05	10.05
22-Jan-02	50.00	52.42	53.00	52.74	52.10	52.42
23-Jan-02	48.75	51.69	52.36	52.09	51.32	51.71
24-Jan-02	52.50	51.82	52.06	51.97	51.86	51.92
25-Jan-02	52.00	51.76	51.81	51.94	51.87	51.91
29-Jan-02	52.00	51.52	51.62	51.76	51.64	51.70
30-Jan-02	51.50	51.29	51.40	51.53	51.46	51.50
31-Jan-02	50.50	50.85	51.10	51.11	51.03	51.07
1-Feb-02	52.00	50.90	50.98	51.29	51.02	51.15
5-Feb-02	52.00	50.98	50.94	51.38	51.10	51.24
6-Feb-02	52.00	51.04	51.04	51.41	51.15	51.28

Figure 5. 9: Calculations of A^5
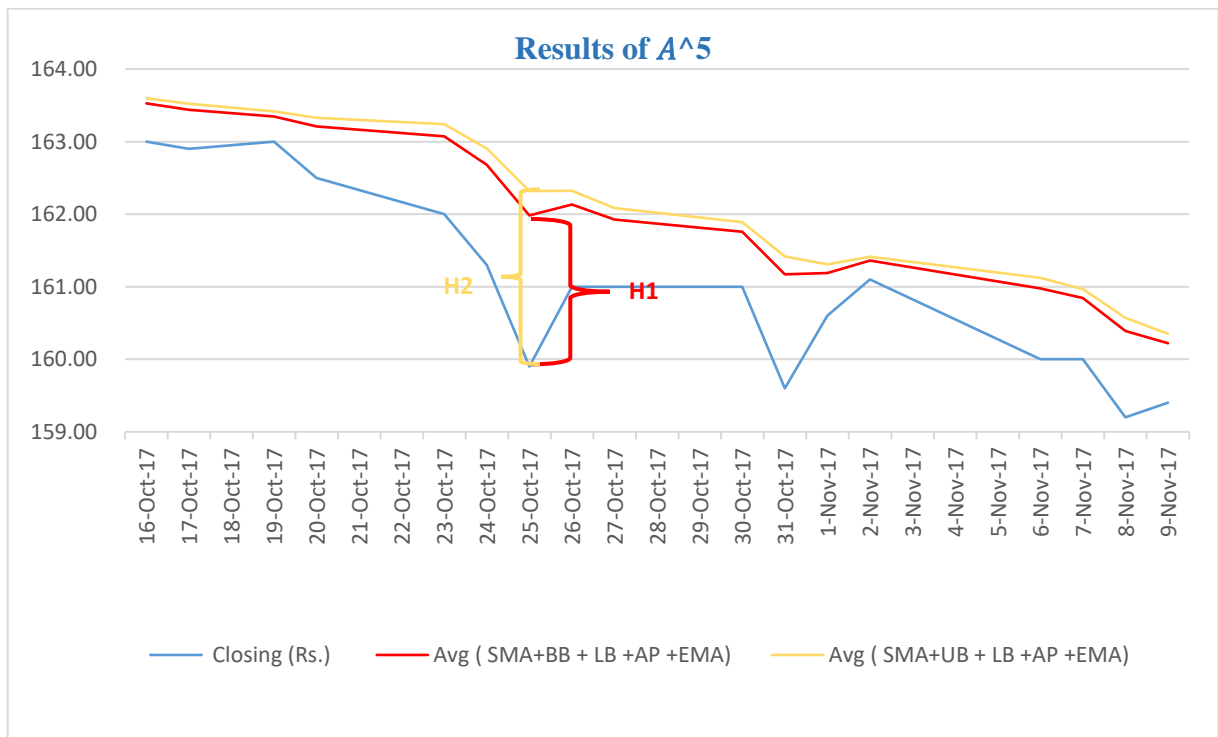
Figure 5. 10: Results of A^5

Step 4 :- From the Figure 5. 10 can identify,

H1 – Difference between Avg (SMA, BB, LB, AP, EMA) and the closing price

H2 – Difference between Avg (SMA, UB, LB, AP, EMA) and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^5 which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg (SMA, BB, LB, AP, EMA).

Step 5 :- Repeat Step 0 to Step 3.

Experiment 1.6. A^6

Step 0 :- Select six different technical indicators from $(A^{ALL}) = \{ A^6 \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- A1(SMA) is equal to A2(BB)

  A1A3A4A5A6A7 almost combined.

  Therefore, ignored A2A3A4A5A6A7 combinations.

- A7(RSI) is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored A1A2A3A4A5A7, A1A2A3A4A6A7, A1A2A3A5A6A7, A1A2A4A5A6A7, A1A3A4A5A6A7, A2A3A4A5A6A7 combinations.

- Since Avg (SMA, BB, LB, AP, EMA) is the best combination of technical indicators according to Figure 5. 10, combining A1A2A3A4A5A7, A1A2A3A4A6A7, A1A2A3A5A6A7, A1A3A4A5A6A7, A2A3A4A5A6A7 can be eliminated.

Step 2 :- Obtained results of A^6 which means obtained the results by merging six different technical indicators from Group A is illustrated in Figure 5. 11.

Step 3 :- Plotted graph with obtained results is demonstrated in Figure 5. 12.

| Date	Closing (Rs.)	Avg (SMA+BB +UB + LB +AP +EMA)
2-Jan-02	58.00	9.78
3-Jan-02	57.75	9.54
4-Jan-02	56.25	9.46
7-Jan-02	55.00	9.31
8-Jan-02	55.00	9.22
9-Jan-02	55.00	9.22
10-Jan-02	54.00	9.06
11-Jan-02	52.75	8.85
15-Jan-02	50.25	8.35
16-Jan-02	49.50	8.31
17-Jan-02	48.00	8.10
18-Jan-02	50.25	8.25
21-Jan-02	50.25	8.38
22-Jan-02	50.00	52.51
23-Jan-02	48.75	51.81
24-Jan-02	52.50	51.92
25-Jan-02	52.00	51.87
29-Jan-02	52.00	51.66

Figure 5. 11: Calculations of A^6
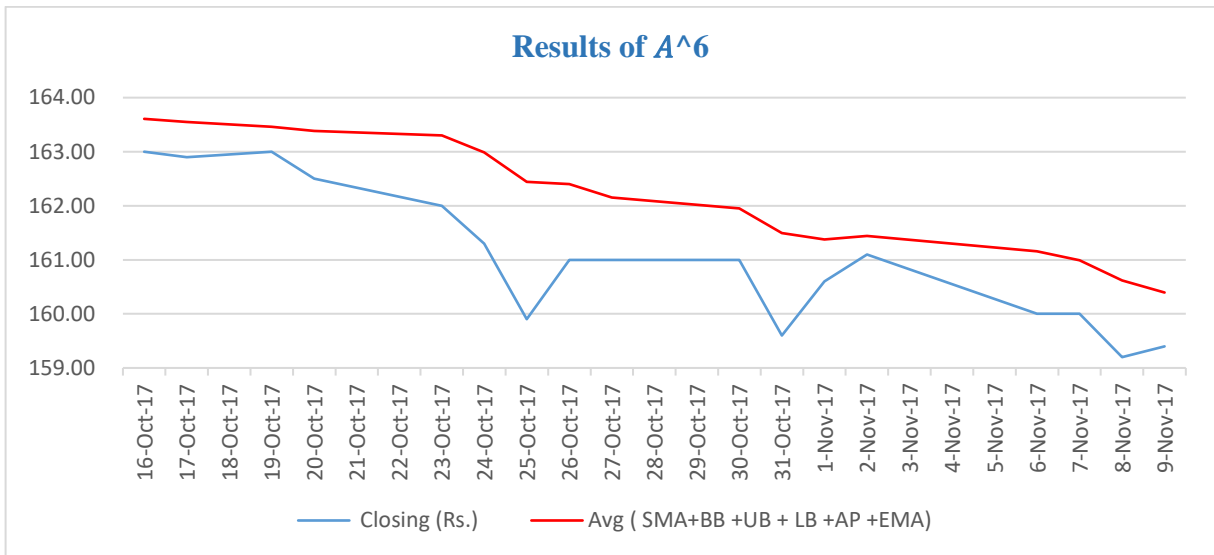
Figure 5. 12: Results of A^6

Step 4 :- From the Figure 5. 12 demonstrates only one combination. Therefore, the best combination of A^6 which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg (SMA, BB, UB, LB, AP, EMA).

Step 5 :- Repeat Step 0 to Step 3.

Experiment 1.7. A^7

Step 0 :- Select seven different technical indicators from (A^{ALL}) = { A^7 }

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- A7(RSI) is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored A1A2A3A4A5A6A7 combinations.

Therefore, skipped Step 2 to Step 4.

Step 5 :- Repeat Step 0 to Step 3 up until all the selection of Group A.

Experiment 1.8. A^{ALL}

Step 6 :- Plotted all the best combinations obtained from the sections of Experiment 1.1. A¹, Experiment 1.2. A², Experiment 1.3. A³, Experiment 1.4. A⁴, Experiment 1.5. A⁵, Experiment 1.6. A⁶ and Experiment 1.7. A⁷ under the Step 4 is demonstrated in Figure 5. 13.
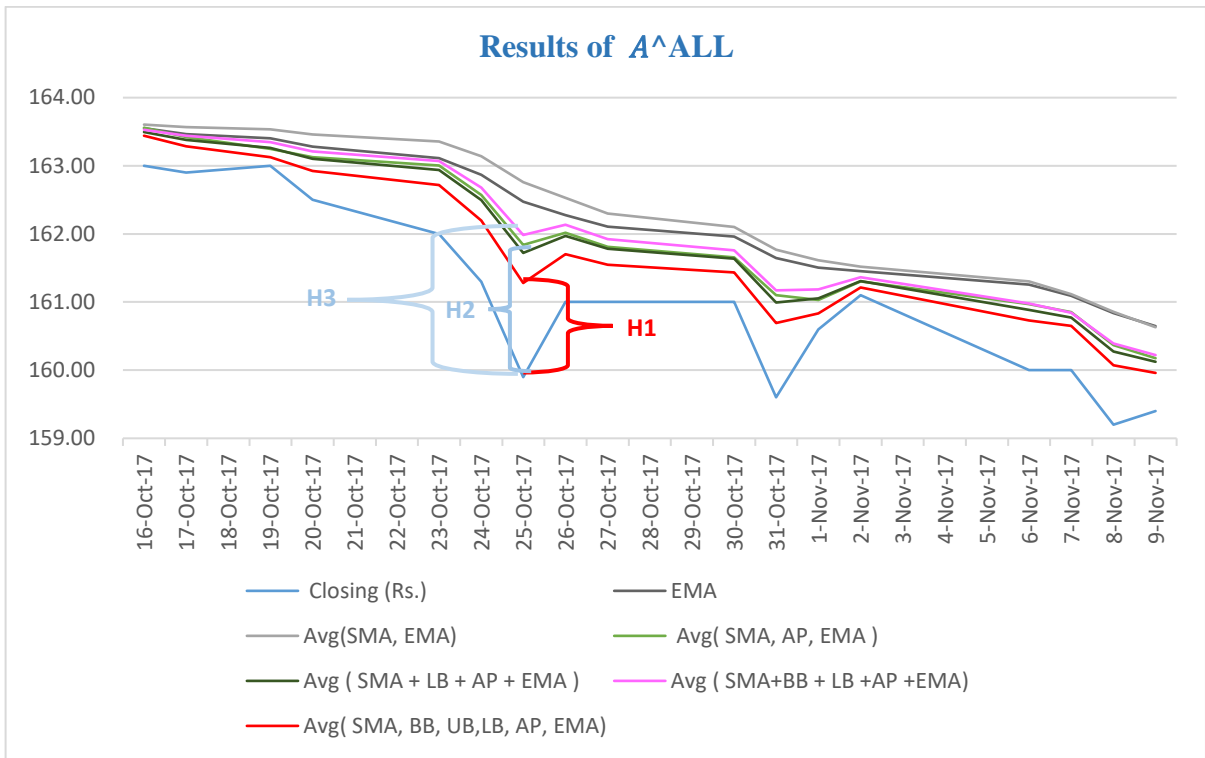
70

Figure 5. 13: Results of A^ALL

Step 7 :- From the Figure 5. 13 can identify,

       H1 – Difference between Avg (SMA, BB, UB, LP, AP, EMA) and the closing price

       H2 – Difference between Avg (SMA, LP, AP, EMA) and the closing price

       H3 – Difference between Avg (SMA, AP, EMA) and the closing price

            H1 < H2 < H3 < …….

Therefore, the best combination of A^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg (SMA, BB, UB, LP, AP, EMA).

5.2.2. Experiment 2

To obtain the results of B^{ALL}, go through those identified combinations in Experiment 2 under the section 4.2.2 Analysis of Combination of Technical Indicators as follow.

    B^{ALL} = All selections of Group B = { B^1, B^2, B^3, B^4 }

Experiment 2.1. B^1

Step 0 :- Select one from (B^{ALL}) = { B^1 }

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

      • Doesn't ignore any combination.

Step 2 :- Obtained results of B^1 which means obtained the results by selecting individual technical indicator from Group B.

Experiment 2.2. B^2

Step 0 :- Select two from $(B^{ALL}) = \{\ B^2\ \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Step 2 :- Obtained results of B^2 which means obtained the results by merging two different technical indicators from Group B.

Experiment 2.3. B^3

Step 0 :- Select three from $(B^{ALL}) = \{\ B^3\ \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Step 2 :- Obtained results of B^3 which means obtained the results by merging three different technical indicators from Group B.

Experiment 2.4. B^4

Step 0 :- Select three from $(B^{ALL}) = \{\ B^4\ \}$

Step 1 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Step 2 :- Obtained results of B^4 which means obtained the results by merging four different technical indicators from Group B.

Experiment 2.5. B^{ALL}

Obtained the results of B^{ALL} from the sections of Experiment 2.1. B[1], Experiment 2.2. B[2], Experiment 2.3. B[4] and Experiment 2.4. B[4] is illustrated in Figure 5. 14.

Date	Closing (R	Std	MACD	CMF	BBW	std + MACD	std + CMF	std + BBW	MACD + CMF	MACD + BBW	CMF + BBW	Avg (std + MACD)	Avg (std + CMF)	Avg (std + BBW)	Avg (MACD + CMF)
2-Jan-02	58.00	0	0	0	-	0	0	-	0	-	-	0	0	-	0
3-Jan-02	57.75	0	0	0	-	0	0	-	0	-	-	0	0	-	0
4-Jan-02	56.25	0	0	0	-	0	0	-	0	-	-	0	0	-	0
7-Jan-02	55.00	0	0	0	-	0	0	-	0	-	-	0	0	-	0
8-Jan-02	55.00	0	0	0	-	0	0	-	0	-	-	0	0	-	0
9-Jan-02	55.00	0	0	0	-	0	0	-	0	-	-	0	0	-	0
10-Jan-02	54.00	0	0	0	-	0	0	-	0	-	-	0	0	-	0
11-Jan-02	52.75	0	0	0	-	0	0	-	0	-	-	0	0	-	0
15-Jan-02	50.25	0	0	0	-	0	0	-	0	-	-	0	0	-	0
16-Jan-02	49.50	0	0	0	-	0	0	-	0	-	-	0	0	-	0
17-Jan-02	48.00	0	0	0	-	0	0	-	0	-	-	0	0	-	0
18-Jan-02	50.25	0	0	0	-	0	0	-	0	-	-	0	0	-	0
21-Jan-02	50.25	0	0	0	-	0	0	-	0	-	-	0	0	-	0
22-Jan-02	50.00	0.801784	0	0	0.06	0.80178373	0.80178373	0.86	0	0.06	0.06	0.400891863	0.400891863	0.43	0
23-Jan-02	48.75	0.959277	0	0	0.07	0.95927696	0.95927696	1.03	0	0.07	0.07	0.479638479	0.479638479	0.52	0
24-Jan-02	52.50	0.143176	0	0	0.01	0.14317567	0.14317567	0.15	0	0.01	0.01	0.071587833	0.071587833	0.08	0
25-Jan-02	52.00	0.090678	0	0	0.01	0.09067792	0.09067792	0.10	0	0.01	0.01	0.045338961	0.045338961	0.05	0
29-Jan-02	52.00	0.147948	0	0	0.01	0.14794819	0.14794819	0.16	0	0.01	0.01	0.073974094	0.073974094	0.08	0
30-Jan-02	51.50	0.081133	0	0	0.01	0.08113288	0.08113288	0.09	0	0.01	0.01	0.040566439	0.040566439	0.04	0
31-Jan-02	50.50	0.100223	0	0.245543	0.01	0.10022297	0.34576598	0.11	0.245543011	0.01	0.25	0.050111483	0.172882989	0.05	0.122771506
1-Feb-02	52.00	0.338849	0	0.241874	0.03	0.33884907	0.58072285	0.37	0.241873772	0.03	0.27	0.169424537	0.290361423	0.18	0.120936886
5-Feb-02	52.00	0.353167	0	0.24168	0.03	0.35316664	0.59484622	0.38	0.241679581	0.03	0.27	0.176583321	0.297423111	0.19	0.12083979
6-Feb-02	52.00	0.319759	0	#DIV/0!	0.03	0.31975899	#DIV/0!	0.34	#DIV/0!	0.03	#DIV/0!	0.159879493	#DIV/0!	0.17	#DIV/0!
7-Feb-02	50.00	0.224309	0	#DIV/0!	0.02	0.22430854	#DIV/0!	0.24	#DIV/0!	0.02	#DIV/0!	0.112154271	#DIV/0!	0.12	#DIV/0!
8-Feb-02	48.25	0.696788	0	#DIV/0!	0.05	0.69678824	#DIV/0!	0.75	#DIV/0!	0.05	#DIV/0!	0.348394119	#DIV/0!	0.38	#DIV/0!
11-Feb-02	49.00	0.47248	-1.292424	#DIV/0!	0.04	-0.81994468	#DIV/0!	0.51	#DIV/0!	(1.26)	#DIV/0!	-0.40997234	#DIV/0!	0.25	#DIV/0!
12-Feb-02	49.50	0.324532	-1.294554	#DIV/0!	0.03	-0.97002263	#DIV/0!	0.35	#DIV/0!	(1.27)	#DIV/0!	-0.485011313	#DIV/0!	0.18	#DIV/0!
13-Feb-02	50.00	0.190901	-1.241584	#DIV/0!	0.02	-1.05068307	#DIV/0!	0.21	#DIV/0!	(1.23)	#DIV/0!	-0.525341534	#DIV/0!	0.10	#DIV/0!
14-Feb-02	50.25	0.152721	-1.165991	#DIV/0!	0.01	-1.01327027	#DIV/0!	0.16	#DIV/0!	(1.15)	#DIV/0!	-0.506635134	#DIV/0!	0.08	#DIV/0!
15-Feb-02	52.00	0.324532	-0.953877	#DIV/0!	0.03	-0.62934542	#DIV/0!	0.35	#DIV/0!	(0.93)	#DIV/0!	-0.314672708	#DIV/0!	0.18	#DIV/0!
18-Feb-02	53.00	0.572703	-0.697048	#DIV/0!	0.05	-0.12434557	#DIV/0!	0.62	#DIV/0!	(0.65)	#DIV/0!	-0.062172783	#DIV/0!	0.31	#DIV/0!
19-Feb-02	52.00	0.305441	-0.567658	#DIV/0!	0.02	-0.26221625	#DIV/0!	0.33	#DIV/0!	(0.54)	#DIV/0!	-0.131108127	#DIV/0!	0.16	#DIV/0!

Figure 5. 14: Calculations of B^{ALL}

5.2.3. Experiment 3

To identify the best combination of A^{ALL} with B^{ALL}, go through those identified combinations in Experiment 3 under the section 4.2.2 Analysis of Combination of Technical Indicators with the data set as follow.

A^{ALL} = All selections of Group A = { $A^1, A^2, A^3, A^4, A^5, A^6, A^7$ }

B^{ALL} = All selections of Group B = { B^1, B^2, B^3, B^4 }

Experiment 3.1. A^1 with B^{ALL}

To identify the best combination of A^1 with B^{ALL}, identify the combinations by combing the combination obtained from Experiment 1.1. A^1 with Experiment 2.5. B^{ALL} and go through those identified combinations in with the data set as follow.

Step 0 :- Select one from selection from (A^{ALL}) = { A^1 }

Step 1 :- Ignored possible(possible but already combined)/impossible combinations. (Almost done in Experiment 1)

Experiment 3.1.1.   A^1(A1) with B^{ALL}

Step 2 :- Select one from (A^1) = { A1 } = SMA

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Step 4 :- Obtained results by merging A^1(A1) with B^1.

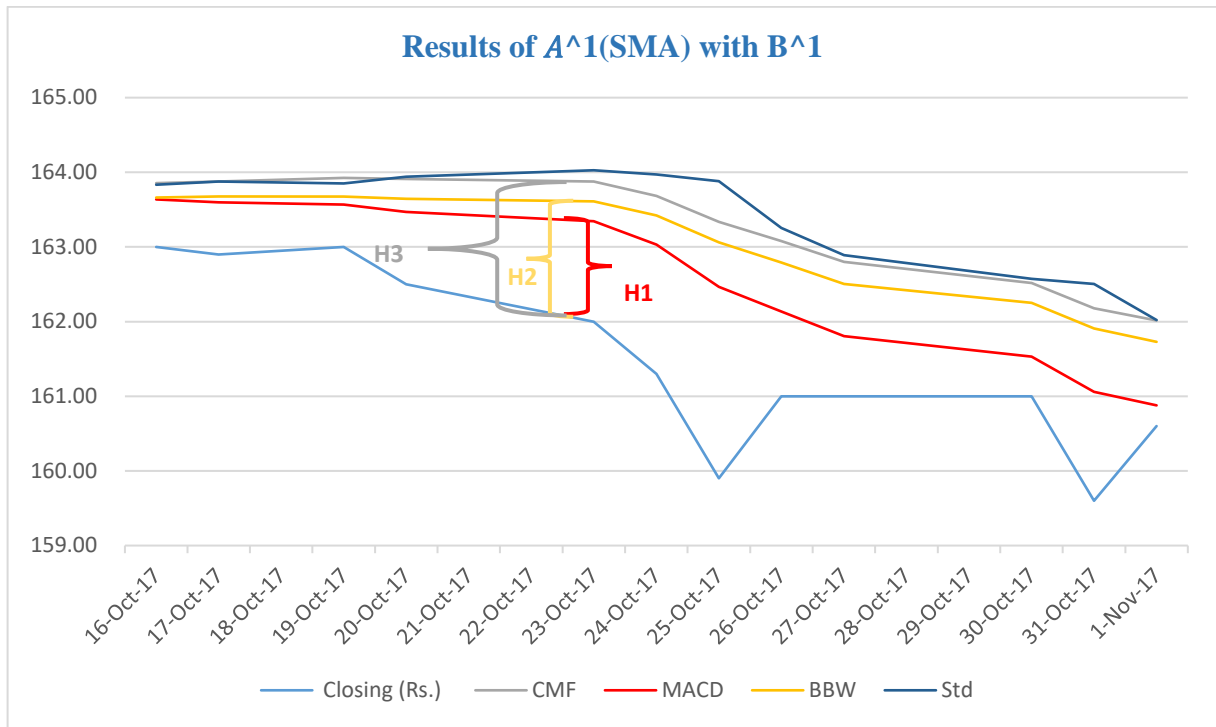Step 5 :- Plotted a graph with obtained results is demonstrated in Figure 5. 15.

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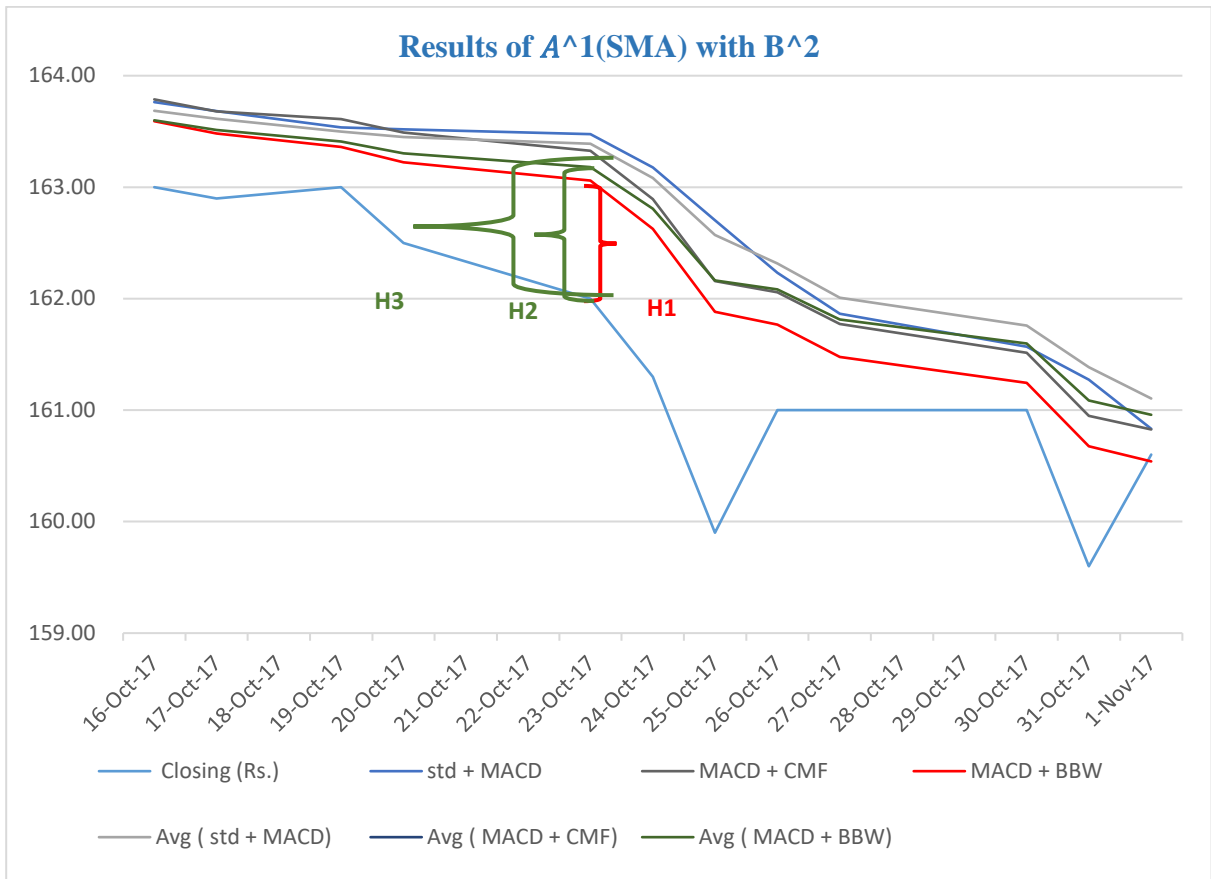
Figure 5. 15: Results of A[1](SMA) with B[1]

Step 6 :- From the Figure 5. 15 can identify,

       H1 – Difference between SMA + MACD and the closing price

       H2 – Difference between SMA + BBW and the closing price

       H3 – Difference between SMA + CMF and the closing price

$$H1 < H2 < H3 < \ldots\ldots.$$

Therefore, the best combination of A^1(A1) merges with B^1 which means identify which combination demonstration the smallest difference between the closing price and the combination as SMA with MACD.

Step 7 :- Ignored possible(possible but already combined)/impossible combinations and obtained results by merging A^1(A1) with B^2

- Since SMA with MACD is the best combination of technical indicator according to Figure 5. 15, combining can be Avg(B2B3), Avg(B2B4), Avg(B3B4), Sum(B2B3), Sum(B2B4), Sum(B3B4) with SMA eliminated.

Step 8 :- Plotted a graph with obtained results is demonstrated in Figure 5. 16.

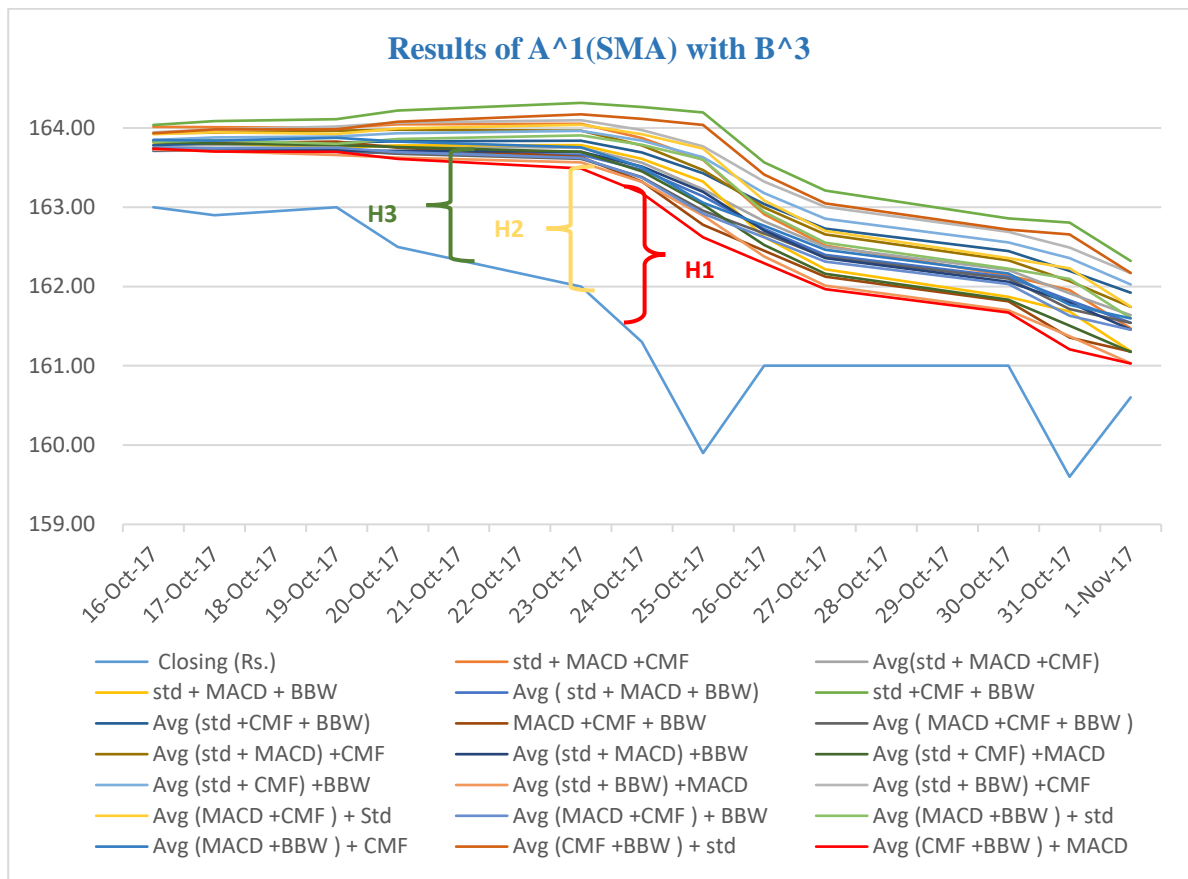Figure 5. 16: Results of A^1(SMA) with B^2

Step 9 :- From the Figure 5. 16 can identify,

H1 – Difference between SMA + MACD + BBW and the closing price

H2 – Difference between SMA + Avg(MACD, BBW) and the closing price

H3 – Difference between SMA + MACD + CMF and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^1(A1) merges with B^2 which means identify which combination demonstration the smallest difference between the closing price and the combination as SMA with MACD and BBW.

Step 10 :- Ignored possible(possible but already combined)/impossible combinations and obtained results by merging A^1(A1) with B^3

- Since SMA with MACD and BBW is the best combination of technical indicator according to Figure 5. 16, combining can be Avg(B1B2B3), Sum(B1B2B3), Sum(B1B3B4), Sum(B2B3B4), Avg(B1B2)B3, Avg(B1B3)B2, Avg(B2B3)B1, Avg(B2B3)B4, Avg(B2B4)B3, Avg(B3B4)B2) with SMA eliminated.

Step 11 :- Plotted a graph with obtained results is demonstrated in Figure 5. 17.

Figure 5. 17: Results of A^1(SMA) with B^3

Step 12 :- From the Figure 5. 17 can identify,

     H1 – Difference between SMA + Avg (CMF, BBW) + MACD and the closing price

     H2 – Difference between SMA + CMF + BBW + MACD and the closing price

     H3 – Difference between SMA + Avg (MACD, CMF) + BBW and the closing price

          H1 < H2 < H3 < …….

Therefore, the best combination of A^1(A1) merges with B^3 which means identify which combination demonstration the smallest difference between the closing price and the combination as SMA with the Average (CMF, BBW) and MACD.

Step 13 :- Ignored possible(possible but already combined)/impossible combinations and obtained results by merging A^1(A1) with B^4

    • Doesn't ignore any combination.

Step 14 :- Plotted a graph with obtained results is demonstrated in Figure 5. 18.

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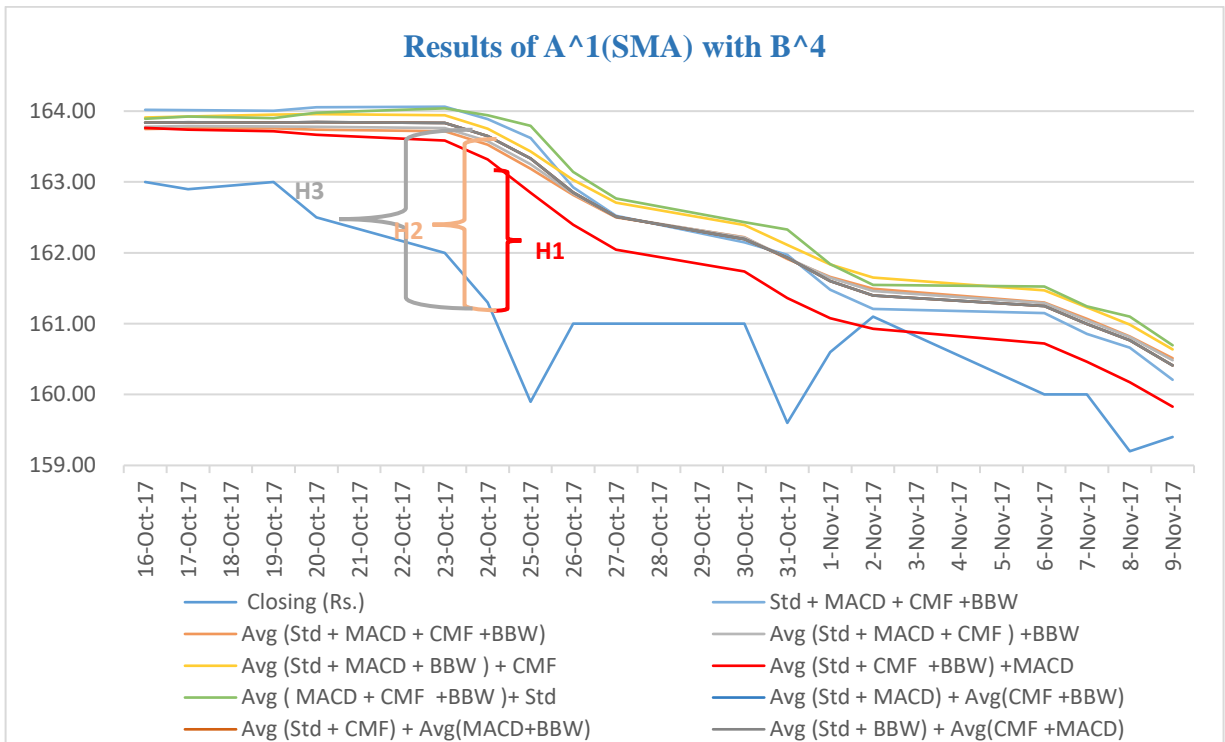
Figure 5. 18: Results of A^1(SMA) with B^4

Step 15 :- From the Figure 5. 18 can identify,

H1 – Difference between SMA + Avg(Std, CMF, BBW) + MACD and the closing price

H2 – Difference between SMA + Avg(Std, MACD, CMF) + BBW and the closing price

H3 – Difference between SMA + Avg(Std, BBW) + Avg(MACD, CMF) and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^1(A1) merge with B^4 which means identify which combination demonstration the smallest difference between the closing price and the combination as SMA with the Average(Std, CMF, BBW) and MACD.

Step 16 :- Plotted best combinations obtained in Step 6, 9, 12 and 15 is demonstrated in Figure 5. 19.

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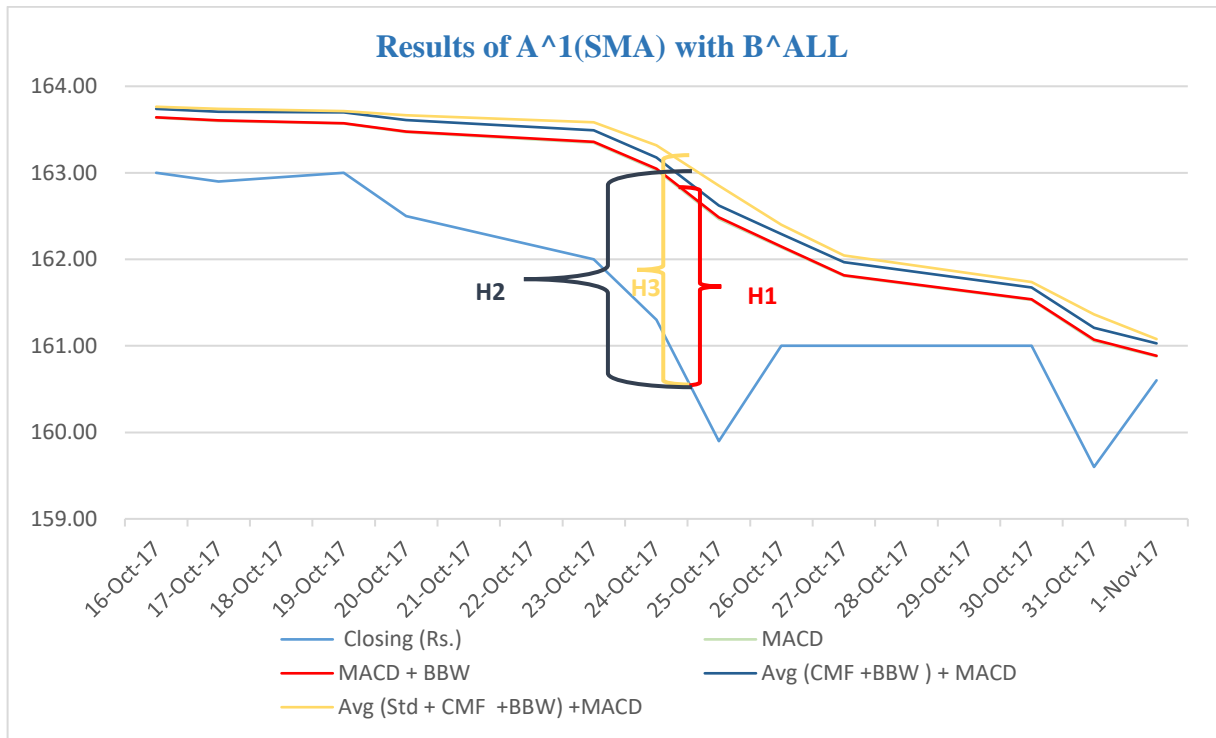
Figure 5. 19: Results of A^1(SMA) with B^{ALL}

Step 17 :- From the Figure 5. 19 can identify,

      H1 – Difference between SMA + MACD + BBW and the closing price

      H2 – Difference between SMA + Avg(Std + CMF + BBW) + MACD and the closing

price

      H3 – Difference between SMA + Avg(CMF + BBW) + MACD and the closing price

          H1 < H2 < H3 < …….

Therefore, the best combination of A^1(A1) merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as SMA with MACD and BBW.

Step 18 :- Repeat Step 2 to Step 17 up until all the selection of A^1.

Experiment 3.1.2. $\quad A^1$(A2) with B^{ALL}

Step 2 :- Select one from $(A^1) = \{$ A2 $\} = $ BB

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- A2(Bollinger Band) because 20-days SMA is equal to 20-days BB.

   It almost analysed in section Experiment 3.1.1. A^1(A1) with B^{ALL}.

   Therefore, ignored A^1(A2) with B^{ALL}.

Experiment 3.1.3. A^1(A3) with B^{ALL}

Step 2 :- Select one from (A^1) = { A3 } = UB

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Go through Step 4 to Step 15 and obtained the best combination of A^1(A3) with B^1, A^1(A3) with B^2, A^1(A3) with B^3 and A^1(A3) with B^4.

Step 16 :- Plotted best combinations obtained in step 6, 9, 12 and 15 is demonstrated in Figure 5. 20.
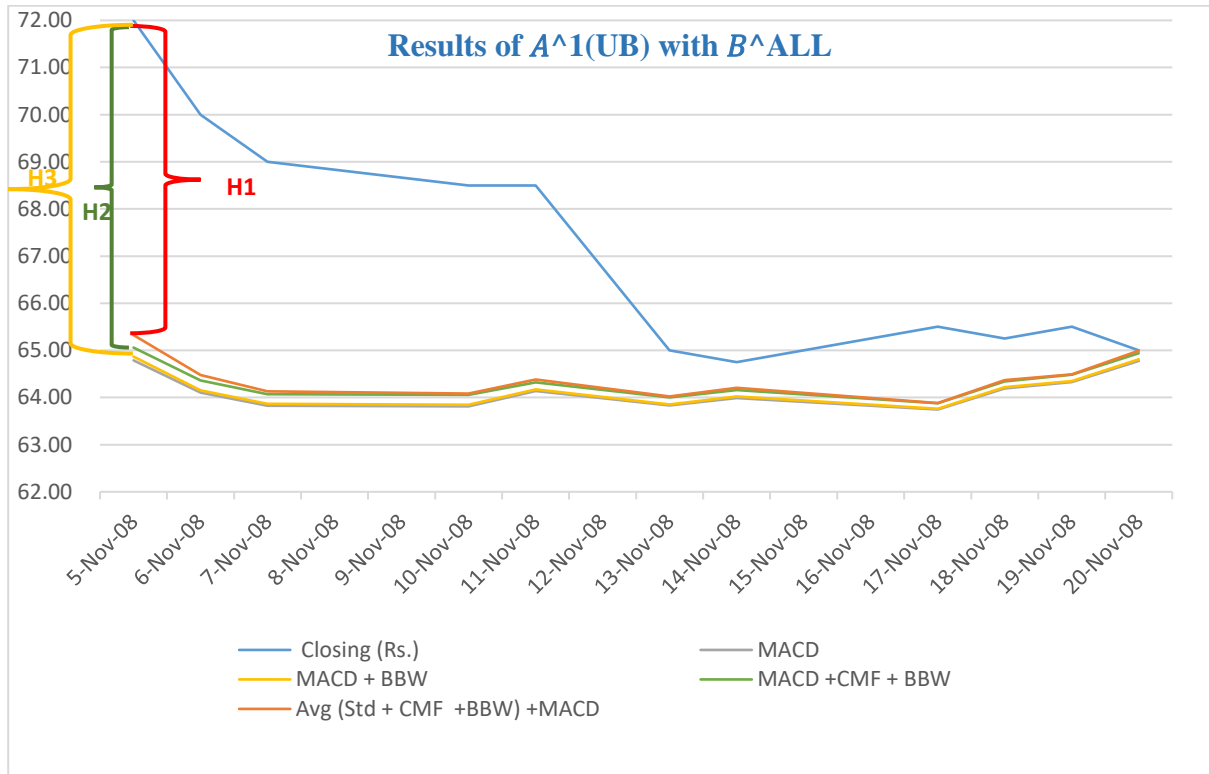
Figure 5. 20: Results of A^1(UB) with B^{ALL}

Step 17 :- From the Figure 5. 20 can identify,

H1 – Difference between UB + Avg (Std, CMF, BBW) + MACD and the closing price

H2 – Difference between UB +MACD + CMF + BBW and the closing price

H3 – Difference between UB + MACD + BBW and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^1(A3) merge with B^{ALL} which means identify which combination demonstration the smallest difference between closing price and the combination as UB + Avg (Std, CMF, BBW) + MACD.

Step 18 :- Repeat Step 2 to Step 17 up until all the selection of A^1.

Experiment 3.1.4. $A^1(A4)$ with B^{ALL}

Step 2 :- Select one from $(A^1) = \{ A4 \} = LB$

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Go through Step 4 to Step 15 and obtained the best combination of $A^1(A4)$ with B^1, $A^1(A4)$ with B^2, $A^1(A4)$ with B^3 and $A^1(A4)$ with B^4.

Step 16 :- Plotted best combinations obtained in step 6, 9, 12 and 15 is demonstrated in Figure 5. 21.
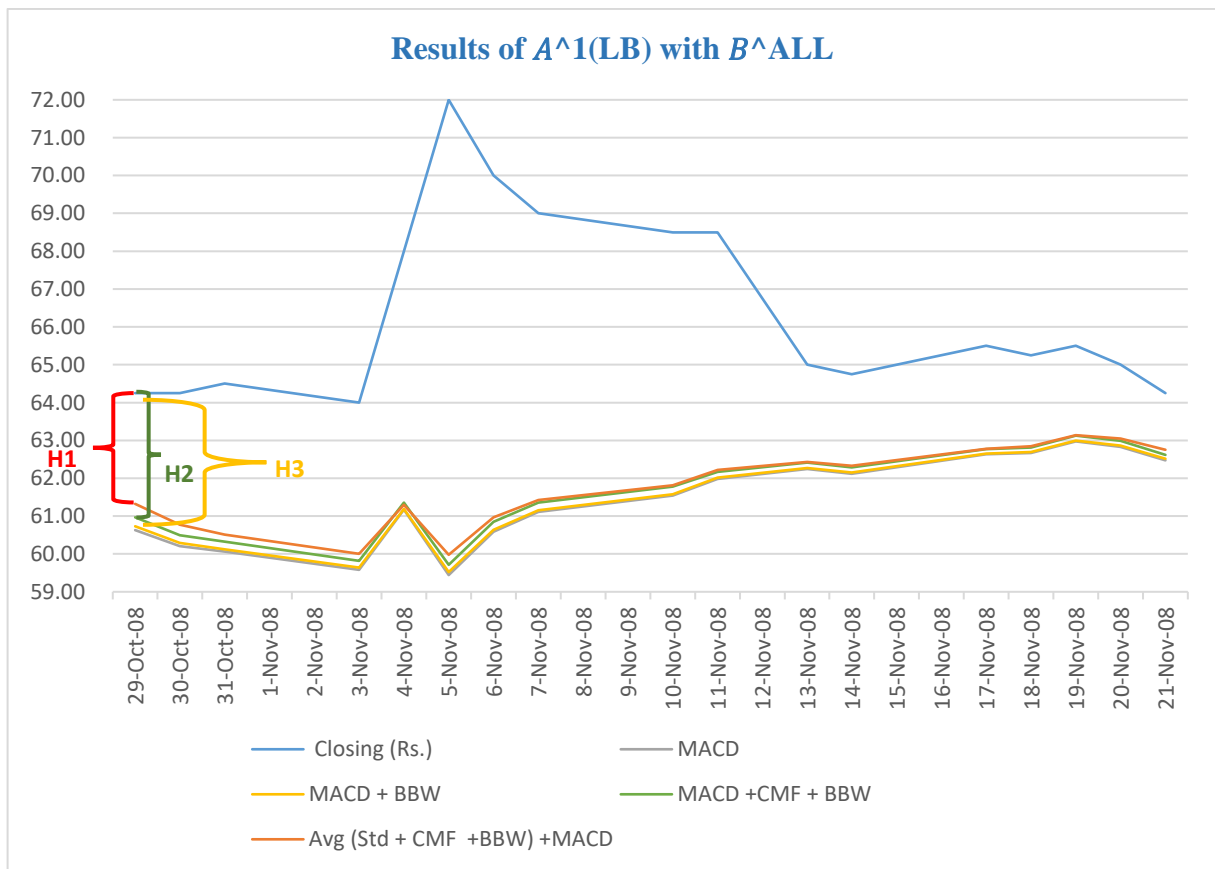
Figure 5. 21: Results of A^1(LB) with B^{ALL}

Step 17 :- From the Figure 5. 21 can identify,

H1 – Difference between LB + Avg(Std, CMF, BBW) + MACD and the closing price

H2 – Difference between LB + MACD + CMF + BBW and the closing price

H3 – Difference between LB + MACD + BBW and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of $A^1(A4)$ merges with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as LB + Avg (Std, CMF, BBW) + MACD.

Step 18 :- Repeat Step 2 to Step 17 up until all the selection of A^1.

Experiment 3.1.5. A^1(A5) with B^{ALL}

Step 2 :- Select one from $(A^1) = \{ A5 \} = AP$

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Go through Step 4 to Step 15 and obtained the best combination of A^1(A5) with B^1, A^1(A5) with B^2, A^1(A5) with B^3 and A^1(A5) with B^4.

Step 16 :- Plotted best combinations obtained in step 6, 9, 12 and 15 is demonstrated in Figure 5. 22.
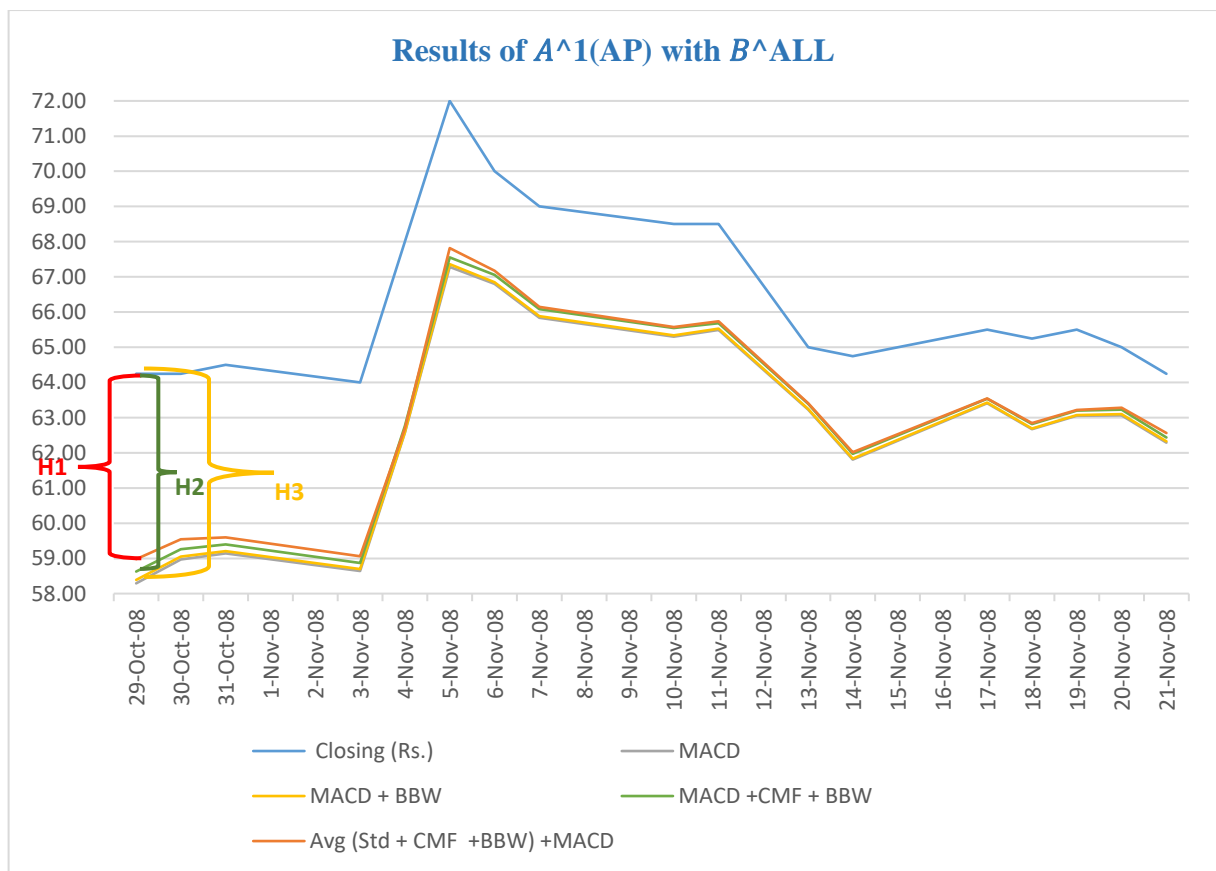
Figure 5. 22: Results of A^1(AP) with B^{ALL}

Step 17 :- From the Figure 5. 22 can identify,

H1 – Difference between AP + Avg (Std, CMF, BBW) + MACD and the closing price

H2 – Difference between AP + MACD + CMF +BBW and the closing price

H3 – Difference between AP + MACD + BBW and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^1(A5) merges with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as AP + Avg(Std, CMF, BBW) + MACD.

Step 18 :- Repeat Step 2 to Step 17 up until all the selection of A^1.

Experiment 3.1.6. A^1(A6) with B^{ALL}

Step 2 :- Select one from (A^1) = { A6 } = EMA

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- Doesn't ignore any combination.

Go through Step 4 to Step 15 and obtained the best combination of A^1(A6) with B^1, A^1(A6) with B^2, A^1(A6) with B^3 and A^1(A6) with B^4.

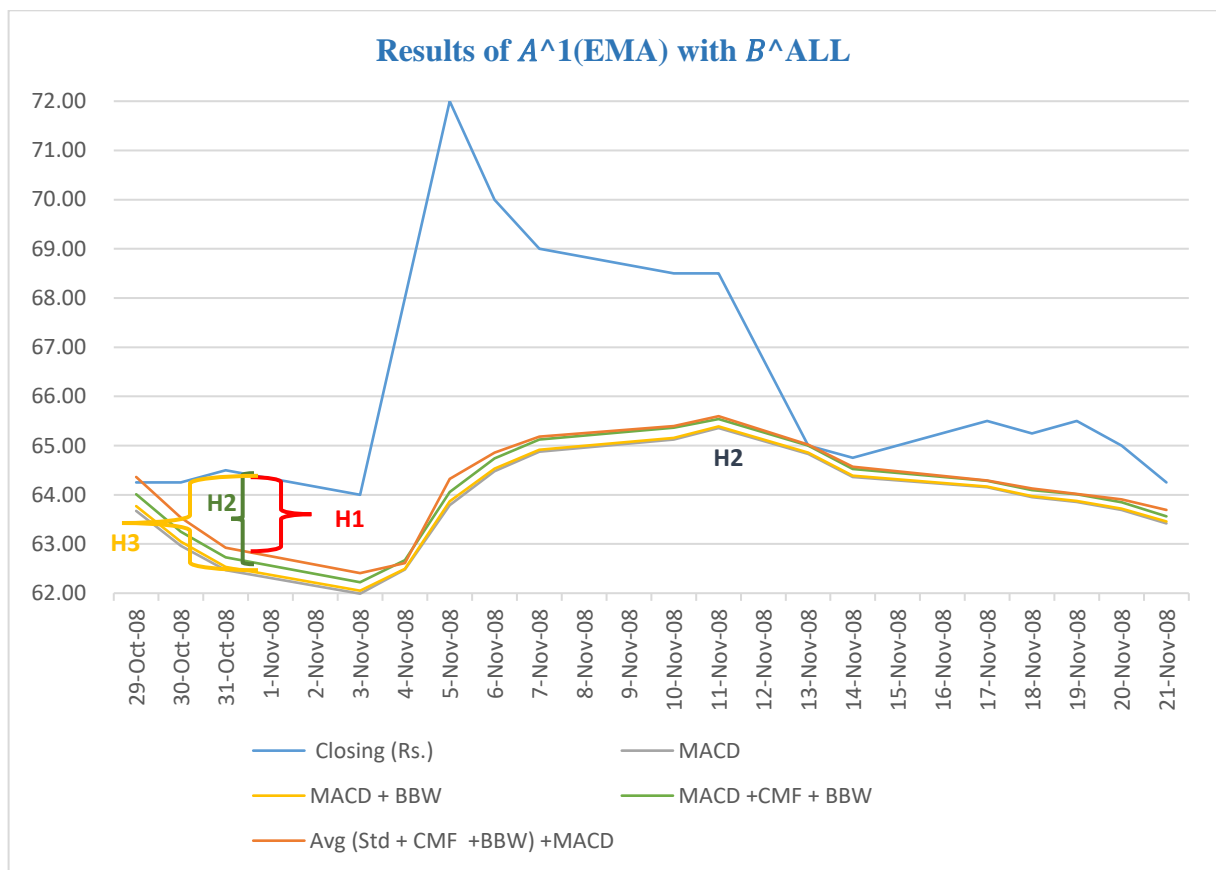Step 16 :- Plotted best combinations obtained in step 6, 9, 12 and 15 is demonstrated in Figure 5. 23.

Figure 5. 23: Results of A[1](EMA) with B[ALL]

Step 17 :- From the Figure 5. 23 can identify,

H1 – Difference between EMA + Avg(Std, CMF, BBW) + MACD and the closing price

H2 – Difference between EMA + MACD + CMF + BBW and the closing price

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H3 – Difference between EMA + MACD +BBW and the closing price

$$H1 < H2 < H3 < \ldots.$$

Therefore, the best combination of A^1(A6) merges with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as EMA + Avg(Std, CMF, BBW) + MACD.

Step 18 :- Repeat Step 2 to Step 17 up until all the selection of A^1.

Experiment 3.1.7. A^1(A7) with B^{ALL}

Step 2 :- Select one from $(A^1) = \{$ A7 $\} = $ RSI

Step 3 :- Ignored possible(possible but already combined)/impossible combinations.

- RSI is calculated based on the comparison of the gain of stock to the loss of stock. It is the ratio of the upward EMA of stock to the downward movements for the stock. Therefore, ignored all the combinations.

Experiment 3.1.8. A^1 with B^{ALL}

Step 19 :- Plotted all the best combinations obtained from the sections of Experiment 3.1.1 A¹(A1), Experiment 3.1.2 A¹(A2), Experiment 3.1.3 A¹(A3), Experiment 3.1.4 A¹(A4), Experiment 3.1.5 A¹(A5), Experiment 3.1.6 A¹(A6) and Experiment 3.1.7 A¹(A7) under the Step 15 is demonstrated in Figure 5. 24.
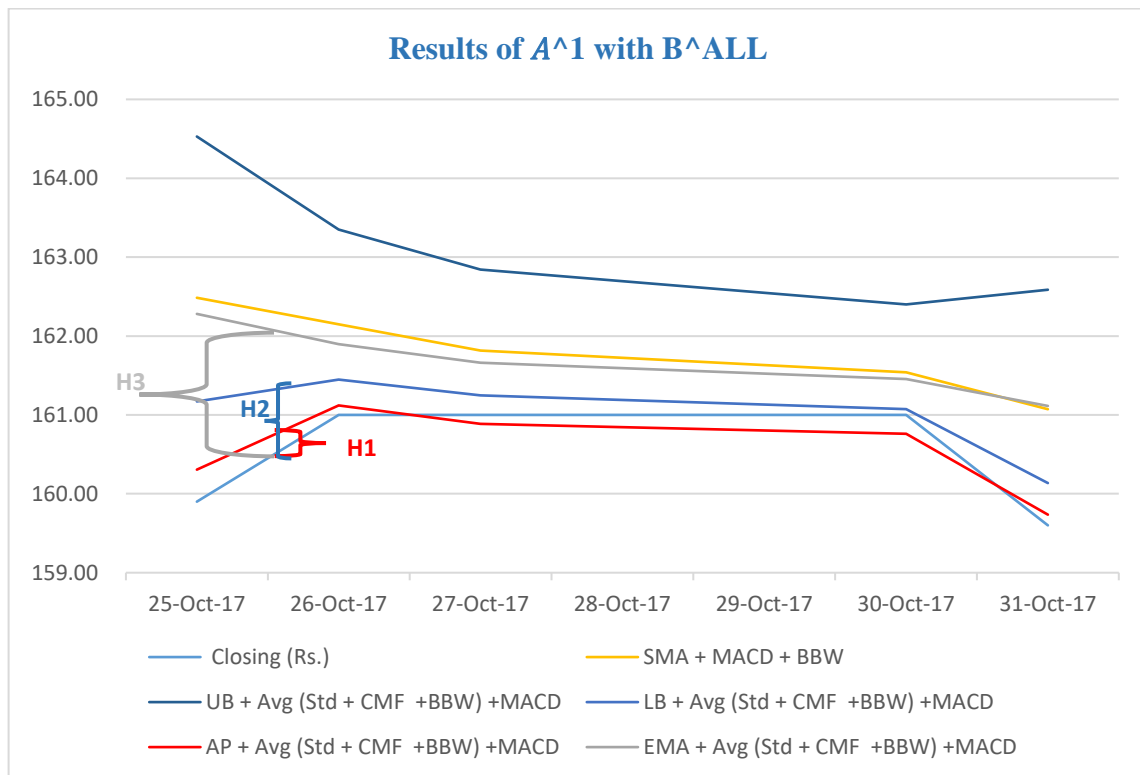

Figure 5. 24: Results of A¹ with B^ALL

Step 20 :- From the Figure 5. 24 can identify,

H1 – Difference between AP + Avg(Std, CMF, BBW) + MACD and the closing price

H2 – Difference between LB + Avg(Std, CMF, BBW) + MACD and the closing price

H3 – Difference between EMA + Avg(Std, CMF, BBW) + MACD and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^1 merges with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as AP with Avg(Std, CMF, BBW) and MACD.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.2. A^2 with B^{ALL}

Step 0 :- Select two from selection from $(A^{ALL}) = \{A^2\}$

Go through Step 1 to Step 20 and obtained the best combination of each pair of A^2 with B^{ALL}.
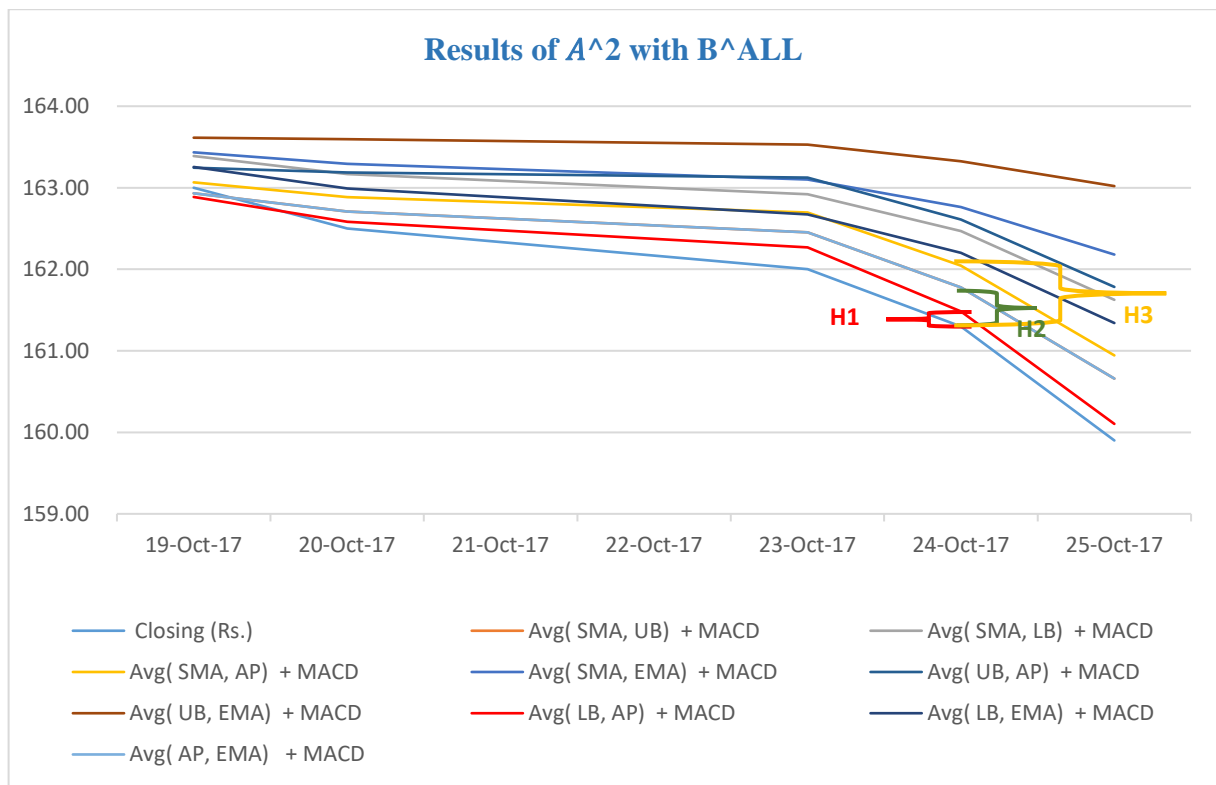

Results of A^2 with B^ALL

Figure 5. 25: Results of A^2 with B^{ALL}

From the Figure 5. 25 can identify,

H1 – Difference between Avg(LB, AP) + MACD and the closing price

H2 – Difference between Avg(AP, EMA) + MACD and the closing price

H3 – Difference between Avg(SMA, AP) + MACD and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^2 merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(LB, AP) + MACD.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.3. A^3 **with** B^{ALL}

Step 0 :- Select two from selection from $(A^{ALL}) = \{A^3\}$

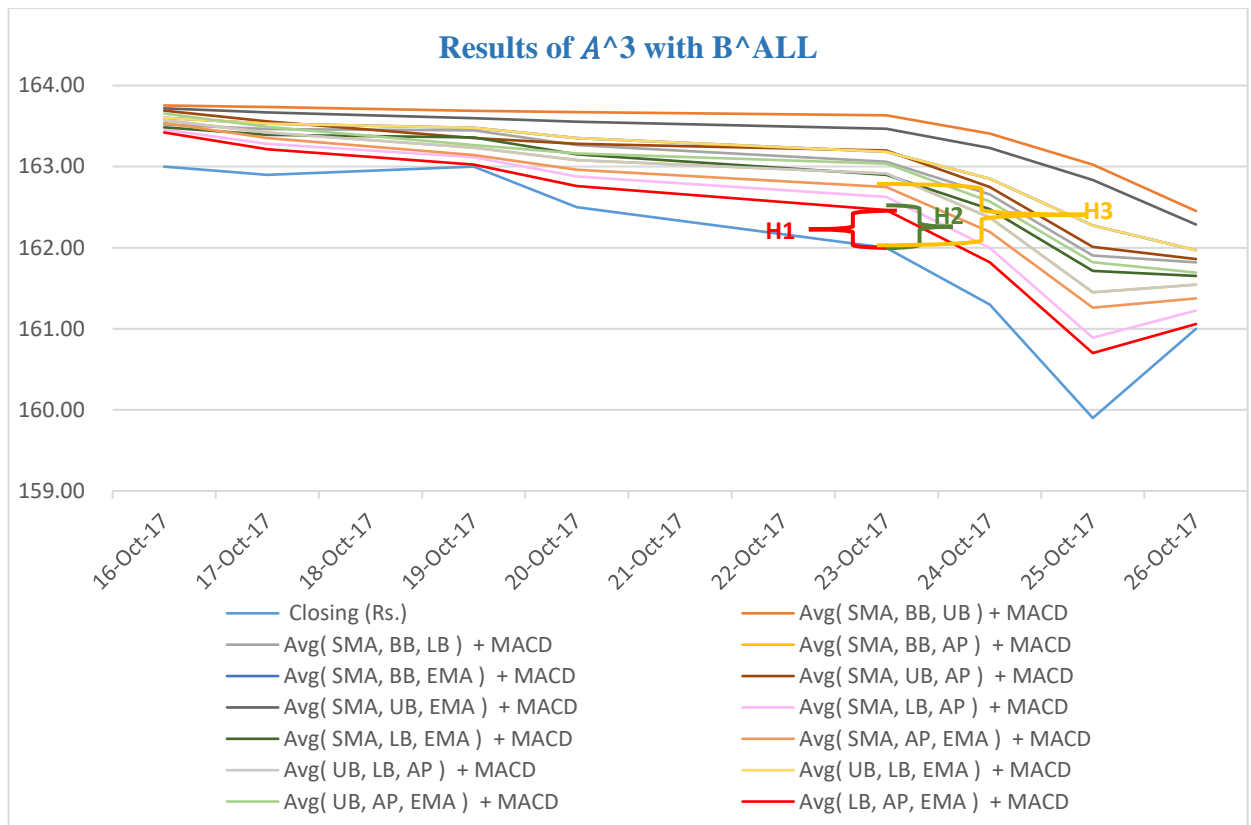Go through Step 1 to Step 20 and obtained the best combination of each pair of A^3 with B^{ALL}.

Figure 5. 26: Results of A^3 with B^{ALL}

From the Figure 5. 26 can identify,

       H1 – Difference between Avg(LB, AP, EMA) + MACD and the closing price

       H2 – Difference between Avg(SMA, LB, AP) + MACD and the closing price

       H3 – Difference between Avg(SMA, AP, EMA) + MACD and the closing price

            H1 < H2 < H3 < …….

Therefore, the best c Identify the best combination of A^3 merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(LB, AP, EMA) + MACD.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.4. A^4 **with** B^{ALL}

Step 0 :- Select two from selection from $(A^{ALL}) = \{A^4\}$

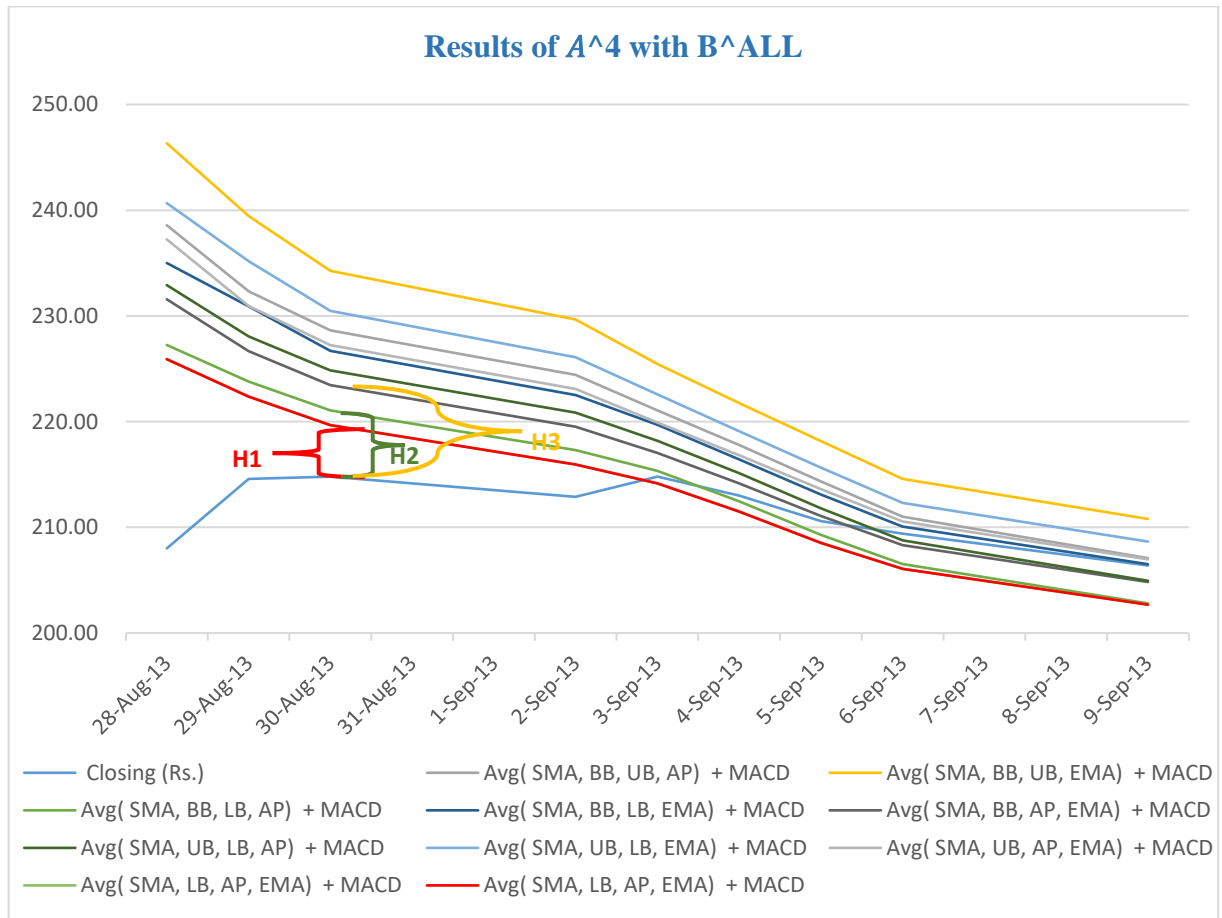Go through Step 1 to Step 20 and obtained the best combination of each pair of A^4 with B^{ALL}.

Figure 5. 27: Results of A^4 with B^{ALL}

From the Figure 5. 27 can identify,

> H1 – Difference between Avg(SMA, LB, AP,EMA) + MACD and the closing price
>
> H2 – Difference between Avg(SMA, BB, LB, AP) + MACD and the closing price
>
> H3 – Difference between Avg(SMA, BB, AP,EMA) + MACD and the closing price
>
> > H1 < H2 < H3 < …….

Therefore, the best c Identify the best combination of A^4 merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(SMA, LB, AP,EMA) + MACD.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.5. A^5 **with** B^{ALL}

Step 0 :- Select two from selection from $(A^{ALL}) = \{A^5\}$

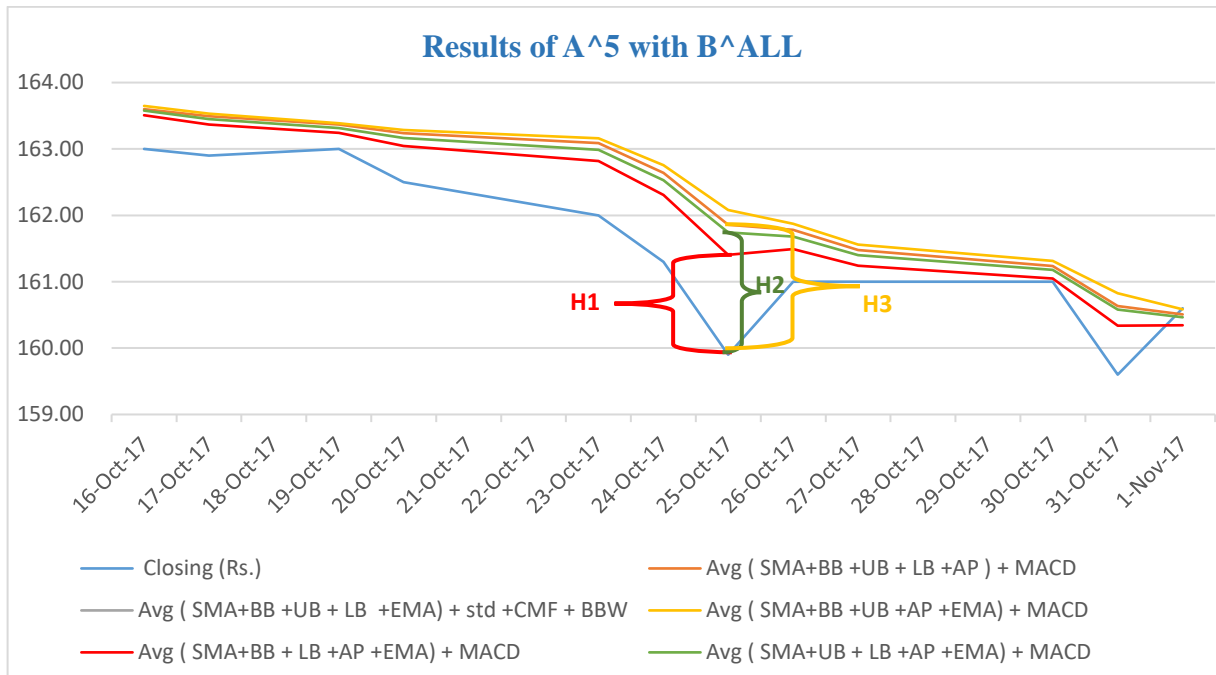Go through Step 1 to Step 20 and obtained the best combination of A^5 each pair of with B^{ALL}.

Figure 5. 28: Results of A^5 with B^{ALL}

From the Figure 5. 28 can identify,

      H1 – Difference between Avg(SMA, BB, LB, AP,EMA) + MACD and the closing price

      H2 – Difference between Avg(SMA, UB, LB, AP,EMA) + MACD and the closing price

      H3 – Difference between Avg(SMA, UB, LB, AP,EMA) + MACD and the closing price

           H1 < H2 < H3 < …….

Therefore, the best c Identify the best combination of A^5 merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(SMA, BB, LB, AP,EMA) + MACD.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.6. A^6 with B^{ALL}

Step 0 :- Select two from selection from $(A^{ALL}) = \{A^6\}$

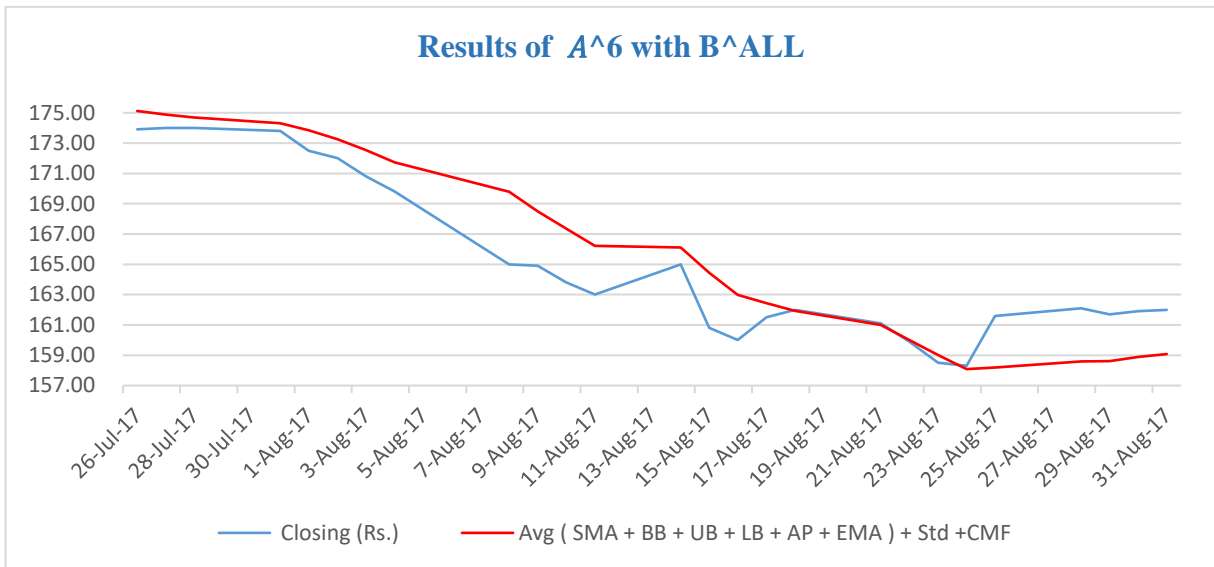Go through Step 1 to Step 20 and obtained the best combination of each pair of A^6 with B^{ALL}.

Figure 5. 29: Results of A^6 with B^{ALL}

From the Figure 5. 29 can identify, the best combination of A^6 merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(SMA, BB, UB, LB, AP, EMA) + Std + CMF.

Ignore Step 18 to Step 20 because of A^6 has only one possible combination.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.7. A^7 with B^{ALL}

Step 0 :- Select seven from selection from $(A^{ALL}) = \{A^7\}$

Step 1 :- Experiment 1.7 under section 5.2.1 obtained there is no possible combinations. Therefore, skipped Step 2 to Step 20.

Step 21 :- Repeat Step 0 to Step 17 up until all the selection of Group A.

Experiment 3.8. A^{ALL} with B^{ALL}

Step 22 :- Plotted all the best combinations obtained from the sections of Experiment 3.1.8 A^1 with B^{ALL}, Experiment 3.2 A^2 with B^{ALL}, Experiment 3.3 A^3 with B^{ALL}, Experiment 3.4 A^4 with B^{ALL}, Experiment 3.5 A^5 with B^{ALL}, Experiment 3.6 A^6 with B^{ALL} and Experiment 3.7 A^7 with B^{ALL} under the Step 20 is demonstrated in Figure 5. 30.

Figure 5. 30: Results of A^{ALL} with B^{ALL}

Step 23 :- From the Figure 5. 30 can identify,

H1 – Difference between Avg(SMA, BB, UB, LB, AP, EMA) + Std + CMF and the closing price

H2 – Difference between Avg(SMA, BB, LB, AP, EMA) + MACD and the closing price

H3 – Difference between Avg(SMA, LB, AP, EMA) + MACD and the closing price

H1 < H2 < H3 < …….

Therefore, the best combination of A^{ALL} merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(SMA, BB, UB, LB, AP, EMA) + Std + CMF.

5.2.4. Experiment 4

To identify the best combination of A^{ALL} and A^{ALL} with B^{ALL}, go through the results obtained in the section 5.2.1 Experiment 1 and 5.2.3 Experiment 3 which is amplified in Experiment 4 under the section 4.2.2 Analysis of Combination of Technical Indicators.
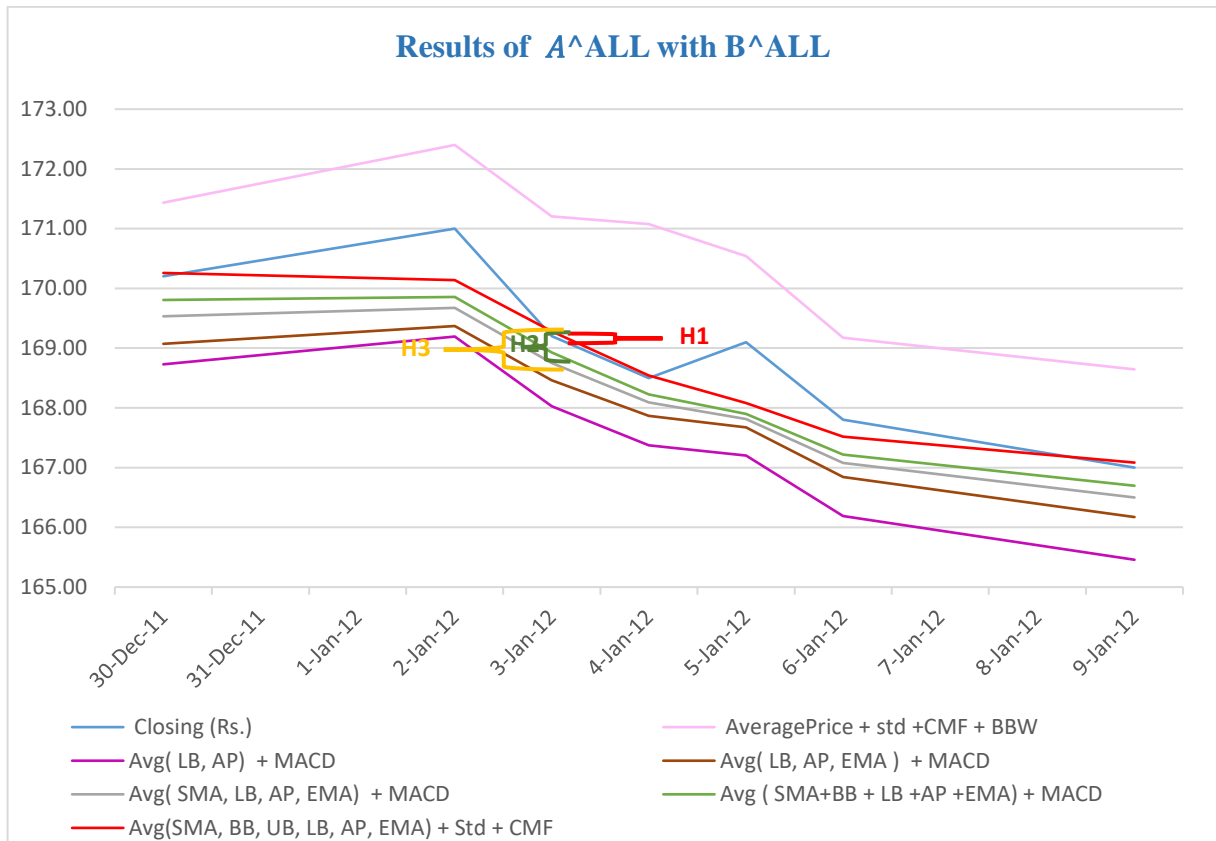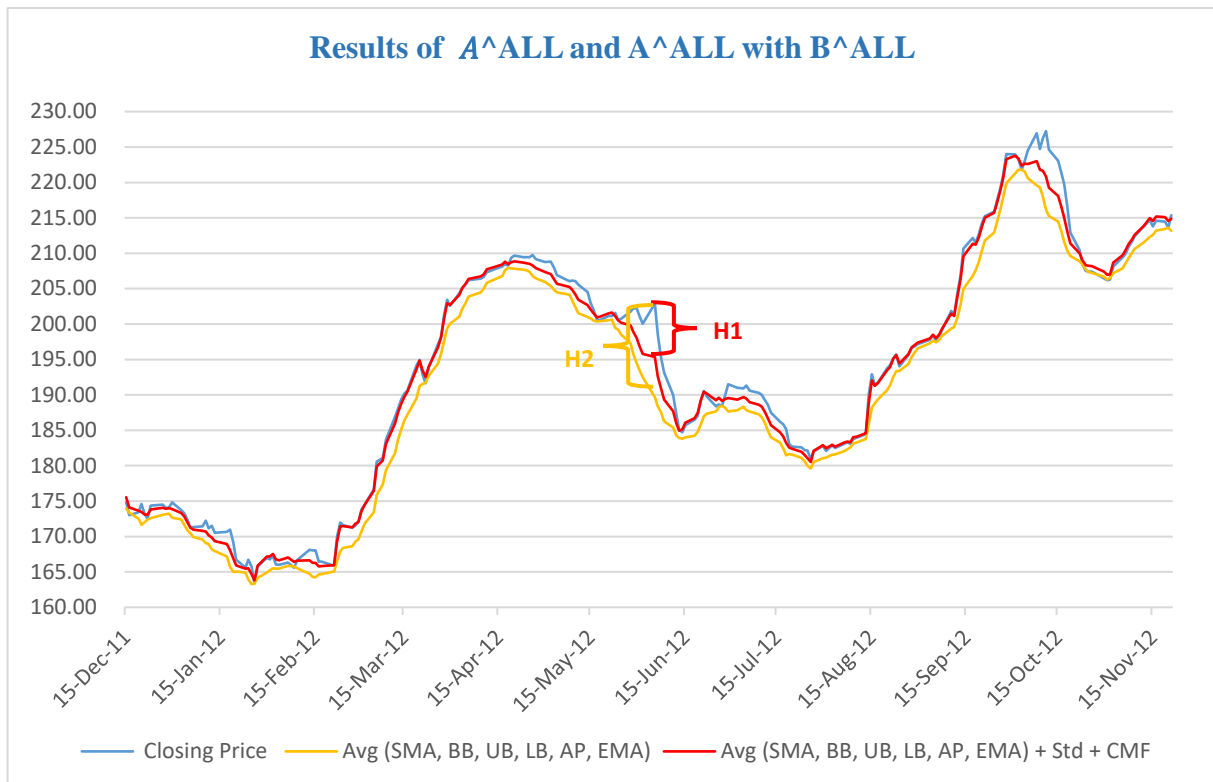
89

Figure 5. 31: Results of A^{ALL} and A^{ALL} with B^{ALL}

From the Figure 5. 31 can identify,

H1 – Difference between Avg(SMA, BB, UB, LB, AP, EMA) + Std + CMF and the closing price

H2 – Difference between Avg(SMA, BB, UB, LB, AP, EMA) and the closing price

H1 < H2

Therefore, the best combination of A^{ALL} and A^{ALL} merge with B^{ALL} which means identify which combination demonstration the smallest difference between the closing price and the combination as Avg(SMA, BB, UB, LB, AP, EMA) + Std + CMF.

5.3. Summary

This chapter provided the evaluation of the results obtained from the graphical view of the individual and combination of technical indicators. By using these graphical views obtained the best combination of technical indicators to predict the stock price. Finally, by using these graphical views came up with the best combination to predict price is obtained as the summation of the 14-days Standard Deviation , 20-days Chaikin Money Flow Indicator with the average of 14-days Simple Moving Average, 14-days Bollinger Band, 14-days Upper Band, 14-days Lower Band, Average Price, 14-days Exponential Moving Average.

Chapter 6.   Conclusion

6.1.   Conclusion of the Thesis

In this research, we tried to introduce the best combination of technical indicators. Our aim was to obtain the best combination of technical indicators which can be achieved the stock price in the stock market. There were the solutions which can be obtained stock price by using individual indicators, but none of those were best to achieve stock price than the combination of technical indicators. Hence, the aim of this research was to come up with a solution which can achieve the best stock price by using combination of technical indicators.

According to the evaluation which we have done, for 20-days Simple Moving Average, 20-days Bollinger Band, 20-days Upper Band, 20-days Lower Band, Average Price, 14-days Exponential Moving Average, 14-days Relative Strength Index, 14-days Standard Deviation, 20-days Chaikin Money Flow Indicator, Bollinger Band Width, Moving Average Convergence Divergence and obtained the best solution as the 14-days Standard Deviation, 20-days Chaikin Money Flow Indicator with the average of 14-days Simple Moving Average, 14-days Bollinger Band, 14-days Upper Band, 14-days Lower Band, Average Price, 14-days Exponential Moving Average.

This combination was able to achieve the best combination to predict stock price. Figure 5.31 demonstrated the final evaluation of the combination. Which means our combination was able to achieve the best stock price. This is a significant achievement because we have passed a combination of technical indicators can obtain a better prediction than the individual technical indicators.

6.2.   Future Work

Discovering the best combination of technical indicators to predict stock prices is a very wide scope which can be applied combination of technical indicators, market-specific domain knowledge various fundamental parameters such as political and economic factors with the effect the stock market can consider as input variables. However, this research limits the scope to considerate only the technical indicators as input variables. It's better if we can improve this as by communicating with stockbrokers' investors can incorporate market-specific domain knowledge various fundamental parameters such as political and economic factors with the effect the stock market can also take into consideration other than the technical indicators as input variables as well.

Our approach required to take the original equations to execute the combination of technical indicator process. It's better if we can execute the combination of technical indicator without taking original equations as well. To achieve that we need to do some considerable modifications for the existing equations of the existing technical indicators. We need to find a way to recognized data without help of the original equations. For that we have to mark the embedded data using some sort of mechanism which can be separately recognized the data of the original equations.

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Appendix A

Data Analysis Environment

A. 1 Results obtained from two possible technical indicators from Group A with all the possible combinations of technical indicators from Group B illustrated in Figure A. 1.

Avg(SMA, UB) + MACD	Avg(SMA, LB) + MACD	Avg(SMA, AP) + MACD	Avg(SMA, EMA) + MACD	Avg(UB, AP) + MACD	Avg(UB, EMA) + MACD	Avg(LB, AP) + MACD	Avg(LB, EMA) + MACD	Avg(AP, EMA) + MACD
29.33	-	29.33	-	29.33	-	29.33	-	29.33
28.63	-	28.63	-	28.63	-	28.63	-	28.63
28.38	-	28.38	-	28.38	-	28.38	-	28.38
27.92	-	27.92	-	27.92	-	27.92	-	27.92
27.67	-	27.67	-	27.67	-	27.67	-	27.67
27.67	-	27.67	-	27.67	-	27.67	-	27.67
27.17	-	27.17	-	27.17	-	27.17	-	27.17
26.54	-	26.54	-	26.54	-	26.54	-	26.54
25.04	-	25.04	-	25.04	-	25.04	-	25.04
24.92	-	24.92	-	24.92	-	24.92	-	24.92
24.29	-	24.29	-	24.29	-	24.29	-	24.29
24.75	-	24.75	-	24.75	-	24.75	-	24.75
25.13	-	25.13	-	25.13	-	25.13	-	25.13
51.54	52.20	51.54	53.00	52.34	53.80	50.74	52.20	51.54
50.76	51.38	50.71	52.39	51.67	53.35	49.75	51.43	50.76
51.85	51.82	51.61	52.20	51.75	52.35	51.46	52.06	51.85
52.27	51.57	51.91	52.02	52.00	52.11	51.82	51.93	52.27
52.08	51.30	51.64	51.89	51.79	52.04	51.49	51.74	52.08
51.94	51.12	51.43	51.71	51.51	51.79	51.35	51.63	51.94

Figure A. 1: Results of A^2 with B^{ALL}

A. 2 Results obtained from three possible technical indicators from Group A with all the possible combinations of technical indicators from Group B illustrated in Figure A. 2.

Avg(SMA, BB, UB) + MACD	Avg(SMA, BB, LB) + MACD	Avg(SMA, BB, AP) + MACD	Avg(SMA, BB, EMA) + MACD	Avg(SMA, UB, AP) + MACD	Avg(SMA, UB, EMA) + MACD	Avg(SMA, LB, AP) + MACD	Avg(SMA, LB, EMA) + MACD	Avg(SMA, AP, EMA) + MACD	Avg(UB, LB, AP) + MACD	Avg(UB, LB, EMA) + MACD	Avg(UB, AP, EMA) + MACD	Avg(LB, AP, EMA) + MACD
0	0	0	0	19.5556	0	19.5556	0	19.5556	19.5556	0	19.5556	19.5556
0	0	0	0	19.083333	0	19.0833	0	19.0833	19.0833	0	19.0833	19.0833
0	0	0	0	18.916667	0	18.9167	0	18.9167	18.9167	0	18.9167	18.9167
0	0	0	0	18.611111	0	18.6111	0	18.6111	18.6111	0	18.6111	18.6111
0	0	0	0	18.444444	0	18.4444	0	18.4444	18.4444	0	18.4444	18.4444
0	0	0	0	18.444444	0	18.4444	0	18.4444	18.4444	0	18.4444	18.4444
0	0	0	0	18.111111	0	18.1111	0	18.1111	18.1111	0	18.1111	18.1111
0	0	0	0	17.694444	0	17.6944	0	17.6944	17.6944	0	17.6944	17.6944
0	0	0	0	16.694444	0	16.6944	0	16.6944	16.6944	0	16.6944	16.6944
0	0	0	0	16.611111	0	16.6111	0	16.6111	16.6111	0	16.6111	16.6111
0	0	0	0	16.194444	0	16.1944	0	16.1944	16.1944	0	16.1944	16.1944
0	0	16.5	0	16.5	0	16.5	0	16.5	16.5	0	16.5	16.5
0	0	16.75	0	16.75	0	16.75	0	16.75	16.75	0	16.75	16.75
53.5345	52.4655	52.0278	53	52.5623	53.5345	52.4655	52.0278	52.0278	52.0278	53	52.5623	51.4933
52.9788	51.6998	51.254	52.3706	51.893486	53.0102	50.6145	51.7311	51.2853	51.254	52.3706	51.9248	50.6458
52.0597	51.8688	51.7262	52.1236	51.821641	52.219	51.6307	52.0281	51.8855	51.7262	52.1236	51.981	51.7901
51.7212	51.6003	51.8294	51.9016	51.889817	51.962	51.7689	51.8411	52.0702	51.8294	51.9016	52.1307	52.0098
51.5451	51.3478	51.5754	51.7417	51.674029	51.8403	51.4768	51.643	51.8706	51.5754	51.7417	51.9693	51.772
51.2505	51.1423	51.3532	51.538	51.407263	51.5921	51.2991	51.4839	51.6948	51.3532	51.538	51.7489	51.6407
50.9418	50.8082	50.8333	51.2472	50.900149	51.3141	50.7665	51.1804	51.2056	50.8333	51.2472	51.2724	51.1388
50.958	50.5062	51.0159	51.1524	51.241772	51.3783	50.79	50.9265	51.4361	51.0159	51.1524	51.662	51.2102
50.914	50.4431	51.1746	51.117	51.410048	51.3524	50.9392	50.8815	51.613	51.1746	51.117	51.8484	51.3776
51.0167	50.5004	51.2024	51.2006	51.415551	51.1128	50.9803	50.9974	51.5004	51.2024	51.2006	51.8126	51.3062

Figure A. 2: Results of A^3 with B^{ALL}

A. 3 Results obtained from four possible technical indicators from Group A with all the possible combinations of technical indicators from Group B illustrated in Figure A. 3.

Avg(SMA, BB, UB, AP) + MACD	Avg(SMA, BB, UB, EMA) + MACD	Avg(SMA, BB, LB, AP) + MACD	Avg(SMA, BB, LB, EMA) + MACD	Avg(SMA, BB, AP, EMA) + MACD	Avg(SMA, UB, LB, AP) + MACD	Avg(SMA, UB, LB, EMA) + MACD	Avg(SMA, UB, AP, EMA) + MACD	Avg(SMA, LB, AP, EMA) + MACD	Avg(SMA, LB, AP, EMA) + MACD
14.66666667	0	14.66666667	0	14.66666667	14.66666667	0	14.66666667	14.66666667	14.66666667
14.3125		14.3125		14.3125	14.3125	0	14.3125	14.3125	14.3125
14.1875	0	14.1875	0	14.1875	14.1875		14.1875	14.1875	14.1875
13.95833333	0	13.95833333	0	13.95833333	13.95833333	0	13.95833333	13.95833333	13.95833333
13.83333333	0	13.83333333	0	13.83333333	13.83333333	0	13.83333333	13.83333333	13.83333333
13.83333333	0	13.83333333	0	13.83333333	13.83333333	0	13.83333333	13.83333333	13.83333333
13.58333333	0	13.58333333	0	13.58333333	13.58333333	0	13.58333333	13.58333333	13.58333333
13.27083333	0	13.27083333	0	13.27083333	13.27083333	0	13.27083333	13.27083333	13.27083333
12.52083333	0	12.52083333	0	12.52083333	12.52083333	0	12.52083333	12.52083333	12.52083333
12.45833333	0	12.45833333	0	12.45833333	12.45833333	0	12.45833333	12.45833333	12.45833333
12.14583333	0	12.14583333	0	12.14583333	12.14583333	0	12.14583333	12.14583333	12.14583333
12.375	0	12.375	0	12.375	12.375	0	12.375	12.375	12.375
12.5625	0	12.5625	0	12.5625	12.5625	0	12.5625	12.5625	12.5625
52.6717252	53.40089186	51.86994147	52.59910814	52.27083333	52.27083333	53	52.6717252	51.86994147	51.86994147
52.0049361	52.8424361	51.04565914	51.88315914	51.54880952	51.52529762	52.36279762	52.028448	51.06917105	51.06917105
51.85730212	52.15535767	51.71412645	52.01218201	51.90519841	51.78571429	52.08376984	51.97678625	51.83361058	51.83361058
51.83254134	51.88668949	51.74186342	51.79601157	51.96783862	51.78720238	51.84135053	52.01317759	51.92249966	51.92249966
51.61712886	51.74183503	51.46918067	51.59388684	51.76458713	51.54315476	51.66786093	51.83856122	51.69061303	51.69061303
51.35455453	51.49318877	51.27342166	51.4120559	51.57018186	51.3139881	51.45262233	51.6107483	51.52961542	51.52961542
50.89386148	51.20428893	50.79363852	51.10406597	51.12292745	50.84375	51.15417745	51.17303893	51.07281597	51.07281597

Figure A. 3: Results of A^4 with B^{ALL}

A. 4 Results obtained from five possible technical indicators from Group A with all the possible combinations of technical indicators from Group B illustrated in Figure A. 4.

Avg (SMA+BB +UB + LB +AP) + MACD	Avg (SMA+BB +UB + LB +EMA) + std +CMF +	Avg (SMA+BB +UB +AP +EMA) + MACD	Avg (SMA+BB + LB +AP +EMA) + MACD	Avg (SMA+UB + LB +AP +EMA) + MACD
11.733333	11.733333	11.733333	11.733333	11.73333
11.45	11.45	11.45	11.45	11.4
11.35	11.35	11.35	11.35	11.3
11.166667	11.166667	11.166667	11.166667	11.16666
11.066667	11.066667	11.066667	11.066667	11.06666
11.066667	11.066667	11.066667	11.066667	11.06666
10.866667	10.866667	10.866667	10.866667	10.86666
10.616667	10.616667	10.616667	10.616667	10.61666
10.016667	10.016667	10.016667	10.016667	10.01666
9.9666667	9.9666667	9.9666667	9.9666667	9.966666
9.7166667	9.7166667	9.7166667	9.7166667	9.716666
9.9	9.9	9.9	9.9	9.
10.05	10.05	10.05	10.05	10.0
52.416667	45.95169	52.73738	52.095953	52.41666
51.688095	49.228159	52.090616	51.323194	51.70690
51.821429	49.062971	51.974286	51.859746	51.91701
51.761905	49.67197	51.942685	51.870143	51.90641
51.52381	49.313056	51.760135	51.641776	51.70095
51.290476	48.616345	51.527884	51.462978	51.49543
50.85	50.075517	51.113431	51.033253	51.07334
50.902381	51.139336	51.290055	51.018976	51.15451
50.97619	53.046992	51.380497	51.097964	51.23923
51.042857	#DIV/0!	51.408967	51.15316	51.28106

Figure A. 4: Results of A^5 with B^{ALL}

A. 5 Results obtained from six possible technical indicators from Group A with all the possible combinations of technical indicators from Group B illustrated in Figure A. 5.

Avg (SMA+BB +UB + LB +AP +EMA) + MACD
9.78
9.54
9.46
9.31
9.22
9.22
9.06
8.85
8.35
8.31
8.10
8.25
8.38
52.51
51.81

Figure A. 5: Results of A^6 with B^{ALL}

A. 5 Results obtained from all the possible technical indicators from Group A with all the possible combinations of technical indicators from Group B illustrated in Figure A. 6.

AveragePrice + std +CMF + BBW	Avg(LB, AP) + MACD	Avg(LB, AP, EMA) + MACD	Avg(SMA, LB, AP, EMA) + MACD	Avg (SMA+BB + LB +AP +EMA) + MACD	Avg (SMA+BB +UB + LB +AP +EMA) + std + CMF
61.62	60.36	60.14	60.01	59.93	60.07
60.22	60.13	60.00	59.94	59.90	59.96
58.21	59.39	59.45	59.51	59.54	59.57
57.40	58.51	58.73	58.89	58.99	59.17
56.99	57.65	57.99	58.24	58.40	58.67
56.50	56.90	57.30	57.63	57.83	58.16
57.45	57.62	57.74	57.94	58.05	58.21
57.70	57.89	57.88	58.04	58.13	58.27
56.96	57.19	57.33	57.59	57.74	57.99
57.58	57.56	57.55	57.75	57.88	58.04
58.39	58.38	58.16	58.23	58.28	58.31
57.79	58.01	57.91	57.99	58.03	58.08
56.78	57.05	57.21	57.37	57.47	57.62
57.41	57.29	57.35	57.40	57.44	57.48
58.19	57.59	57.60	57.57	57.55	57.62
58.88	57.75	57.79	57.72	57.67	57.77
58.03	57.53	57.60	57.54	57.50	57.48
58.10	57.60	57.68	57.63	57.60	57.66
58.43	57.76	57.80	57.75	57.71	57.74
58.31	57.88	57.90	57.87	57.85	57.90
59.06	58.18	58.20	58.15	58.12	58.23
60.32	58.72	58.70	58.61	58.56	58.73
60.21	58.99	58.93	58.84	58.79	58.85
58.95	58.75	58.76	58.72	58.70	58.71
59.72	58.99	59.03	58.99	58.96	59.11
60.59	59.43	59.40	59.32	59.27	59.36
59.64	59.32	59.33	59.30	59.28	59.31
59.57	59.44	59.42	59.39	59.38	59.40

Figure A. 6: Results of A^{ALL} with B^{ALL}