

Candlestick Patterns' Effectiveness Analysis using TOPSIS Method for Selected Bank Stocks

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Abstract

Financial market generates huge amount of trading information on every day basis. Financial market is represented by share market, commodity market, fixed securities, and different monetary forms and so forth. Further, for the financial derivatives organized markets are also there which also contributes in the pile of trading data. The multifold progression of financial market is because of risk based investment behaviors and diversified investment avenues. The integration of technology based platforms also escalated the volume of operations to the newer heights that also helped the financial market to step up. One well known method of analyzing the market trend is Candlestick Technical Analysis which is Chart based Japanese method of market analysis. Among all the different and advanced methods of market analysis this method is the oldest one and enables understating for the market trend with graphical outlook. This particular research work presented the incidence and also examined effectiveness of the candlestick trends presenting bullish reversal for the 5 leading stocks of Bank Nifty for the period of 10 years from 2010 to 2020. This work is statistically enriched with the help of the back testing method of Data mining to identify the most effective and executing Candlestick trends relating to the regularity of incidences executed in the period of study. Effectiveness of profitability productivity is assessed through TOPSIS over back tested consequences for 5-days holding. Through the results it was concluded that among all the different candlestick patterns Hammer ranked on first position.

Keywords: Financial Market, Candlestick Pattern, Stocks, Bullish Trend, Technical Analysis

Introduction

Analyzing trends of market before making any investment lead into rational investment which ensures better returns and less risk on investment especially in stock market. Market analysis is not a simple process, it has several methods and identifying the most appropriate method of market analysis is quite critical. Financial Market data analysis is also performed through different methods which are broadly

categorized into two types one is suitable for the long term market analysis i.e. Fundamental Analysis and second is suitable for the short term market analysis i.e. Technical Analysis. Among all different methods of technical analysis Candlestick analysis is general and simple by nature and offers visual presentation to the trend of stock and market. Candlestick chart plot area graphically presents price of security and volume data through the plotting of open, high, low, close points incorporating number of shares traded on daily basis, these all lead into better understanding of market trend thorough visual presentation (Gorgulho et al., 2011 and Oliveira et al., 2013) as presented in Figure 1 below.

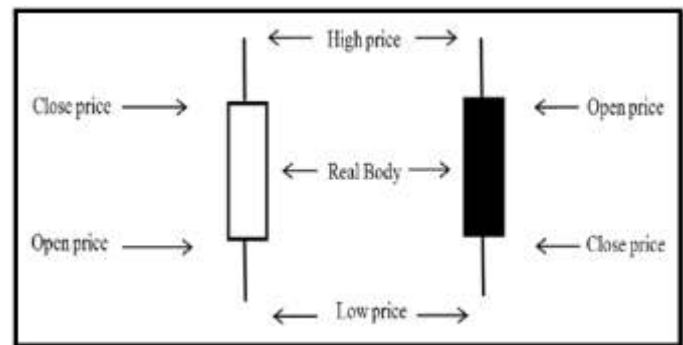
Figure 1: Candlestick Chart Snapshot



Source: <https://hi.investing.com/indices/bank-nifty-chart>

Principal application of the data and information presented in any candlestick chart is used by the investors, professionals, market traders, portfolio managers or practitioners, and researchers having interest in studying market behavior or trend. The data or information presented in Candlestick chart lead into making analysis over the future prices of stock or can say help to forecast the future movements of market and share prices which all help in trading decision to stakeholders (Manoharam and Rajesh, 2019). Plotting of the data related to price in Candlestick Charts is done on the basis of specific time frame that may be a minute basis, daily basis weekly basis or monthly basis through a single plot (Figure 2) which is called as Candle. The color of candle may be either white or black, white indicates bullishness (Price at closing is higher than the Price at opening) and black indicates bearishness (Price at opening is higher than the Price at closing).

Figure 2: White (Bullish) and Black (Bearish) Candle



First practical application of plotting data using Candlestick in market trend analysis was performed by a rice trader Homma in Dojima rice exchange, Japan. Pattern of Candlestick presented through single candle as well as multiple candles have two patterns one is the reversal (Confirms change in previous trend) and another one is continuation (Confirms the continuation of previous trend). Homma presupposed that price behavior or trend of the market helped to understand the behavior or attitude of market participants. Different shapes of the candles present changes or can say the trend of pricing of the market and stock. By the shape of single candle or set of candles in candlestick we can notice a trend in the change of price and market volatility. The patterns in candlestick are judged as direction or signal provider and lead into approaching the right action pertaining to price of stock in near future.

Application and usability of candlestick technique was dominating and most preferable technique among the all the other techniques of market analysis in South Asia in 1980s, because of its visual depiction of the time frame variability and price behavior. Candlestick charting was successfully applied by technicals in different markets and for different time frames. But with the introduction of new methods of financial market analysis broadly classified into technical and fundamental analysis, using the candlestick charting had become debatable in modern-days. There are several arguments in against and favor of using candlestick charting as technical analysis. Brock et al. (1992) commented that technical analysis at some extent depends on reality, as calculating the future prices on the basis of

historical data and some other data values result into deriving some above average returns. Same about the dependability of technical analysis is commented by Adholiya et al. (2019) while studying stochastic pattern of major indices of BSE. With the new information age development, integration of advanced computational techniques, machine learning, artificial intelligence etc are giving new direction to the market trend and price analysis and forecasting. Some of the commonly used models and systems namely Neural Network, Fuzzy System, Vector Machine, Rough Set Theory and few others are the leading and preferred by the technicals (Lin, 2018).

Working with the candlestick charting found easier by the market participants as the candlestick pattern offers good amount of numbers and can be illustrated in natural language and opposite to that adopting the advanced computation techniques for market analysis need better understanding for the market variables make the things challenging for the market participants (Hu et al. , 2019). Even after citing the lack of efficiency for the candlestick based technical analysis by researchers it is widely practiced by the market practitioners because of its integrating behavior with advanced computational techniques as well as amount of information presented over chart. In many researches several advantageous factors of candlestick technical analysis were revealed, such as effectiveness of reversal patterns of candlestick for Malaysian Stock market was discussed by Chin et al. (2016, 2018), predictive power capacity of candlestick was presented by the pattern based trading with KNN (Chmielewski et al., 2015), superior returns were

acclaimed by integration of genetic algorithm based fuzzy and candlestick (Ambily et al., 2017). Boobalan (2014) presented the applicability and significance of candlestick as technical analysis tool for the investors in finding the right plan and making the decision for investments in remunerative stocks. Applicability of Candlestick and other different technical analysis tools over the selected IT companies performed by Pandya (2013) concluded that perfect decision for the investment can be performed with the help of already published data of the finance/ capital market.

Methodology and Material

In this particular research the dataset of 5 leading stocks of Bank Nifty for the period of 10 years from 2010 to 2020 was used for the analysis purpose to assess the effectiveness of trends presented through the candlestick chart. Daily or End of the Day stock price data were used for the evaluation purpose with a good number of daily data points.

Data Anthology

The research is analytical and based on the secondary data values of 5 leading stocks of Bank Nifty of NSE India the leading index in India characterizing several different sectors. As study is working upon the data of 10 years like long duration of the Bank Nifty market, only 5 leading stocks were considered as the sample stocks for the study. The selected 5 leading bank stocks continuously sustained their position in the benchmark index. From the selected 5 leading banks 2 are public sector banks and 3 are private sector banks.

Table 1: Sample Stock of Bank Nifty

S. No.	Name of Stock	Type of Bank
1.	State Bank of India	Public Sector Bank
2.	ICICI	Private Sector Bank
3.	Bank of Baroda	Public Sector Bank
4.	Industrial Development Bank of India	Private Sector Bank
5.	HDFC	Private Sector Bank

Source: <https://in.finance.yahoo.com/>

The research is performed on daily basis historical information of sampled five bank stocks listed in Table 1. The day by day information of the stocks comprises of open, high, low, close and volume information focuses for each share for the 10 years of period generated from Bank Nifty data set. Daily or end of the day data of SBI stock has 2730 data points, ICICI stock has 3735 data points, BOB stock has 2728 data points, IDBI stock has 2727 data points, and HDFC stock has 2732 data points for the sixteen years. Major economic events observed by the study period were highest FII inflows in 2010, 25% down in returns at NIFTY in 2011, 28% higher returns by NIFTY in 2012, higher inflation rate in 2013, election mandate with BJP in 2014 result into market celebration with 31% rally, AQR for banks in 2015, GST in 2017, ILFS blowup, NBFC crisis in 2018, BJP in central government again in 2019, and 2020 COVID outbreak. In totality the sample study period went through several country explicit as well as global economic and geo-political events.

Method Followed For Analysis

The daily data of sampled Bank stocks as stated above were integrated with the Candle scanner software version 4.3.0.5 for further analysis of data under different candle scanner test heads. Candlescanner software is technical analysis software used for the candlestick pattern analysis by the investors or market practitioners. Market practitioners can use Candlescanner major application area such as stock market trading, commodities market, and future markets. The test and application capacities offered by the software lead into assessing the market efficiency in wider scope which helped to formulate the trading strategies for future refinement and market usage. Candlescanner software was used for the backtesting of the dataset of sampled bank stocks to recognize the occurrence of 30 different bullish reversal and 10 different bullish continuation pattern.

Table 2: Candlescanner - Bullish Reversal and Continuation

Bullish Reversal Patterns – Candlescanner	
1. Abandoned Baby	2. Belt Hold
3. Breakaway	4. Concealing Baby Swallow
5. Doji Star	6. Engulfing
7. Hammer	8. Harami Cross
9. Harami	10. Homing Pigeon
11. Inverted Hammer	12. Kicking Up
13. Ladder Bottom	14. Last Engulfing Bottom
15. Matching Low	16. Meeting Lines
17. Morning Doji Star	18. Morning Start
19. Piercing	20. Southern Doji
21. Takuri Line	22. Tasuki Line
23. Three Inside Up	24. Three Outside Up
25. Three Stars in South	26. Three White Soldiers
27. Tri Star	28. Turn Up
29. Tweezers Bottom	30. Unique Three River Bottom
Bullish Continuation Patterns – Candlescanner	
1. Gapping Up Doji	2. Mat Hold
3. Rising Three Methods	4. Rising Window
5. Separating Lines	6. Side by Side White Lines
7. Strong Line	8. Three Line Strikes
9. Upside Gap Three Method	10. Upside Tasuki Gap

Source: Candlescanner Software

The efficiency or effectiveness of the candlestick is analyzed for five days of its event occurrence. Broadly the pattern of incidences can be of four type namely bullish reversal, bearish reversal, bullish continuation and bearish continuation. Pattern of occurrence citing the efficiency of Candlestick on the basis of returns for false signal type lies

for -3.5% to 0.3% returns, for low signal type returns lies in between 0.3% to 2.0%, for medium signal type returns lies in between 2.0% to 3.5% and for high signal type return lies above 3.5%. Table 3 below presents the efficiency classification of candle on short trade and long trade basis.

Table 3: Long and Short Trade Classification of Candle Efficiency-CandleScanner

Signal Type	Long Trade - Returns	Short Trade - Returns
High	>3.5%	< -3.5%
Medium	2% to 3.5%	-3.5% to -2.0%
Low	0.3% to 2%	-2.0% to -0.3%
False	-3.5% to 0.3%	-0.3% to 3.5%

Source: CandleScanner – Backtesting Default setting values

Long trade and short trade classification for candle pattern determination in candle scanner default setting values for high, false, medium and false signal type lies in between

+ve to -ve percentage scores. 29 candle patterns signal efficiency (high, false, medium and false signal type) in percentage is presented in the Table 4 below.

Table 4: False, Low, Medium, High Statistics of Candle Pattern Efficiency

Pattern Name	Code	False	Low	Medium	High
Strong Line+	SL+	12.6%	23.5%	13.3%	50.7%
Strong Line-	SL-	17.8%	17.1%	11.2%	52.6%
Engulfing-	EN-	14.1%	27.1%	16.1%	42.7%
Harami+	HR+	17.3%	22.3%	17.3%	43.1%
Rising Window	RW	14.0%	17.3%	14.0%	54.7%
Last Engulfing Bottom	LEB	18.0%	20.5%	16.7%	44.9%
Falling Window	FW	27.9%	14.0%	13.2%	44.9%
Harami-	HR-	11.5%	30.8%	18.5%	39.2%
Turn Up	TU	11.5%	23.9%	16.2%	48.5%
Last Engulfing Top	LET	12.8%	25.6%	19.2%	42.4%
Engulfing+	EN+	16.1%	28.0%	16.1%	39.8%
Turn Down	TD	17.2%	19.2%	14.1%	49.5%
Three Inside Up	TIU	24.0%	16.7%	9.4%	50.0%
Tasuki Line+	TL+	14.6%	24.7%	14.6%	46.1%
Three Outside Down	TOW	20.2%	19.1%	12.4%	47.2%
One-Candle Shooting Star	OSS	23.5%	21.0%	19.8%	35.8%
Hanging Man	HM	18.7%	25.3%	17.3%	36.0%
Homing Pigeon	HP	19.1%	22.1%	10.3%	48.5%
Three Inside Down	TID	10.9%	29.7%	18.8%	40.6%
Northern Doji	ND	10.2%	27.1%	18.6%	44.1%
Hammer	HM	23.1%	25.0%	17.3%	34.6%
Tasuki Line-	TL-	11.8%	17.7%	19.6%	51.0%

Pattern Name	Code	False	Low	Medium	High
Belt Hold-	BH-	8.3%	22.9%	12.5%	56.3%
Tweezers Top	TT	22.0%	24.4%	19.5%	34.2%
Takuri Line	TL	18.4%	23.7%	13.2%	44.7%
Three Outside Up	TOU	7.9%	21.1%	21.1%	50.0%
Tweezers Bottom	TB	21.1%	18.4%	26.3%	34.2%
Southern Doji	SD	20.6%	17.7%	17.7%	44.1%
Dark Cloud Cover	DCC	6.1%	36.4%	12.1%	45.5%

Source: Candlscanner Output (Note: Full Sample Data)

Efficiency of a candle pattern can be determined through bullish pattern maximum price and bearish pattern minimum price. High and low trade percentage value helped to determine the stop loss order for more pragmatic results, at stop loss point algorithm stops and the highest price is used to statistically calculate the efficiency level.

Data Analysis and Statistical Proceeds

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was used as one of the authenticated variant of Multi-Criteria Analysis methods. TOPSIS method is rank based method in which all the available alternatives are arranged into a fix order to find the best

alternative which is nearest to the ideal statistics, best alternative offers most distant solution. With the help of this method positive ideal solution lead into determining the shortest distance and negative ideal solution helps in determining farthest distance. It's a six step method in which before reaching to the ranking original data matrix has to go with several transformations such as calculating normalized matrix values, deriving weighted normalized matrix with the help of already determined weights, calculating ideal best and worst value, finding the Euclidean distance with the ideal best and worst value and finally the ranking determination through the performance score.

Table 5: Step Wise Formulae - TOPSIS Method

Step	Formulae
1 – Normalized Matrix	$\bar{X}_{ij} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^n X_{ij}^2}}$
2 – Weighted Normalized Matrix	$V_{ij} = \bar{X}_{ij} * W_j$
3 – Ideal Best and Worst	Max and Min of Each Column
4 – Euclidean Distance from Ideal Best	$S_i^+ = \left[\sum_{j=1}^m (V_{ij} - V_j^+)^2 \right]^{0.5}$
5– Euclidean Distance from Ideal Worst	$S_i^- = \left[\sum_{j=1}^m (V_{ij} - V_j^-)^2 \right]^{0.5}$
6 – Performance Score	$P_i = \frac{S_i^-}{S_i^+ + S_i^-}$

Candle pattern occurrence for both bullish and bearish market where sum of occurrence for a particular candle pattern is found more than 1% is presented below in Table 6.

For a particular pattern candlestick present a pattern type such as bullish or bearish continuation, bullish or bearish

reversal. Such pattern type lead into interpret price action and market action such as within a downtrend bullish reversal pattern is formed else it would be a continuation

pattern. Bullish reversal pattern is to be followed by an upside price move came with high trading volume.

Table6: Candle Pattern Occurrence for more than 1% Sum of Occurrence (Market Type – Bullish and Bearish)

Pattern Name	Candles	Pattern Type	Number of occurrences	% sum of occurrences	Average frequency
Strong Line+	1	bullish continuation	302	8.99%	44.9
Strong Line–	1	bearish continuation	287	8.54%	47.2
Engulfing–	2	bearish reversal	255	7.59%	53.2
Harami+	2	bullish reversal	202	6.01%	67.1
Rising Window	2	bullish continuation	179	5.33%	75.7
Last Engulfing Bottom	2	bullish reversal	156	4.64%	86.9
Falling Window	2	bearish continuation	136	4.05%	99.7
Harami–	2	bearish reversal	130	3.87%	104.3
Turn Up	2	bullish reversal	130	3.87%	104.3
Last Engulfing Top	2	bearish reversal	125	3.72%	108.4
Engulfing+	2	bullish reversal	118	3.51%	114.9
Turn Down	2	bearish reversal	99	2.95%	136.9
Three Inside Up	3	bullish reversal	96	2.86%	141.2
Tasuki Line+	2	bullish reversal	89	2.65%	152.3
Three Outside Down	3	bearish reversal	89	2.65%	152.3
One-Candle Shooting Star	1	bearish reversal	81	2.41%	167.3
Hanging Man	1	bearish reversal	75	2.23%	180.7
Homing Pigeon	2	bullish reversal	68	2.02%	199.3
Three Inside Down	3	bearish reversal	64	1.90%	211.8
Northern Doji	1	bearish reversal	59	1.76%	229.7
Hammer	1	bullish reversal	52	1.55%	260.7
Tasuki Line–	2	bearish reversal	51	1.52%	265.8
Belt Hold–	1	bearish reversal	48	1.43%	282.4
Tweezers Top	2	bearish reversal	41	1.22%	330.6
Takuri Line	1	bullish reversal	38	1.13%	356.7
Three Outside Up	3	bullish reversal	38	1.13%	356.7
Tweezers Bottom	2	bullish reversal	38	1.13%	356.7
Southern Doji	1	bullish reversal	34	1.0%	398.7
Dark Cloud Cover	2	bearish reversal	33	1.0%	410.8

Source: CandleScanner Output (Note: Full Sample Data)

Table 7 statistics of candlestick pattern occurrence incorporates top 17 most occurring patterns of Candle with their total occurrence in the study period inclusive of percentage contribution of total candlestick pattern

occurrence for the selected bank stocks in given study period. Occurring patterns helps to predict the price for short-term direction.

Table7: Candlestick Pattern Occurrence Statistics

Basic Candlestick	Group	Number of occurrences	% sum of occurrences	Average frequency
Black Candle	Candles	2,448	18.06%	5.5
Black Spinning Top	Spinning Tops	2,300	16.97%	5.9
White Spinning Top	Spinning Tops	2,161	15.94%	6.3
White Candle	Candles	1,990	14.68%	6.8
High Wave	Spinning Tops	1,167	8.61%	11.6
Short Black Candle	Candles	735	5.4%	18.4
Opening Black Marubozu	Marubozu	707	5.2%	19.2
Opening White Marubozu	Marubozu	591	4.4%	22.9
Short White Candle	Candles	542	4.0%	25.0
Doji	Doji	359	2.6%	37.8
Long White Candle	Candles	243	1.8%	55.8
Long Black Candle	Candles	228	1.7%	59.5
Long-Legged Doji	Doji	59	0.4%	229.7
Four-Price Doji	Doji	17	0.1%	797.4
Closing White Marubozu	Marubozu	5	0.0%	2711.0
Black Marubozu	Marubozu	2	0.0%	6777.5
Closing Black Marubozu	Marubozu	1	0.0%	13555.0

Source: Candlescanner Output (Note: Full Sample Data)

Sequential execution of the steps (Table 5) of TOPSIS method is followed over the dataset presented in Table 4. Step 1 calculation lead into normalized decision matrix

(Table 8) from the raw data, where raw data is normalized byeradicating deviations throughdiverse measurement units and scales.

Table 8: Normalized Matrix

Code	False	Low	Medium	High
SL+	0.136861234	0.186948	0.149787	0.2088
SL-	0.193343648	0.136035	0.126136	0.216625
EN-	0.153154238	0.215587	0.181321	0.175853
HR+	0.187912647	0.177402	0.194835	0.177501
RW	0.152068038	0.137626	0.15767	0.225273
LEB	0.195516048	0.163082	0.188078	0.184914
FW	0.303049875	0.111373	0.14866	0.184914
HR-	0.124913031	0.245021	0.20835	0.161439
TU	0.124913031	0.19013	0.182447	0.19974
LET	0.139033634	0.203654	0.216233	0.174618
EN+	0.174878243	0.222747	0.181321	0.16391
TD	0.186826446	0.152741	0.158796	0.203858
TIU	0.260688065	0.132853	0.105864	0.205917
TL+	0.158585239	0.196495	0.164427	0.189856
TOW	0.219412454	0.151945	0.139651	0.194386
OSS	0.255257063	0.16706	0.222991	0.147437

Code	False	Low	Medium	High
HM	0.20311945	0.201268	0.194835	0.14826
HP	0.207464251	0.175811	0.116	0.19974
TID	0.118395829	0.236271	0.211728	0.167205
ND	0.110792427	0.215587	0.209476	0.181619
HM	0.250912262	0.198881	0.194835	0.142495
TL-	0.128171632	0.140808	0.220738	0.210036
BH-	0.090154622	0.182175	0.140777	0.231863
TT	0.238964059	0.194108	0.219612	0.140847
TL	0.19986085	0.188539	0.14866	0.18409
TOU	0.085809821	0.167856	0.237631	0.205917
TB	0.229188257	0.146376	0.296194	0.140847
SD	0.223757255	0.140808	0.19934	0.181619
DCC	0.066258216	0.289571	0.136272	0.187385

Source: Excel Output

In the next step of TOPSIS weighted Normalized Matrix is to be calculated on the basis of weights assigned to high, false, medium and false signal type. Weights assigned to high, false, medium and false signal type are successively 10%, 10%, 20% and 60%. On the basis of weights assigned

to the signal types weighted normalized decision matrix is calculated through normalized decision matrix in Step 2, Table 9 below presents weighted normalized decision matrix.

Table 9: Weighted Matrix

Code	False	Low	Medium	High
SL+	0.013686	0.018695	0.029957	0.08352
SL-	0.019334	0.013603	0.025227	0.08665
EN-	0.015315	0.021559	0.036264	0.070341
HR+	0.018791	0.01774	0.038967	0.071
RW	0.015207	0.013763	0.031534	0.090109
LEB	0.019552	0.016308	0.037616	0.073965
FW	0.030305	0.011137	0.029732	0.073965
HR-	0.012491	0.024502	0.04167	0.064576
TU	0.012491	0.019013	0.036489	0.079896
LET	0.013903	0.020365	0.043247	0.069847
EN+	0.017488	0.022275	0.036264	0.065564
TD	0.018683	0.015274	0.031759	0.081543
TIU	0.026069	0.013285	0.021173	0.082367
TL+	0.015859	0.019649	0.032885	0.075942
TOW	0.021941	0.015195	0.02793	0.077754
OSS	0.025526	0.016706	0.044598	0.058975
HM	0.020312	0.020127	0.038967	0.059304
HP	0.020746	0.017581	0.0232	0.079896
TID	0.01184	0.023627	0.042346	0.066882
ND	0.011079	0.021559	0.041895	0.072648
HM	0.025091	0.019888	0.038967	0.056998

Code	False	Low	Medium	High
TL-	0.012817	0.014081	0.044148	0.084014
BH-	0.009015	0.018218	0.028155	0.092745
TT	0.023896	0.019411	0.043922	0.056339
TL	0.019986	0.018854	0.029732	0.073636
TOU	0.008581	0.016786	0.047526	0.082367
TB	0.022919	0.014638	0.059239	0.056339
SD	0.022376	0.014081	0.039868	0.072648
DCC	0.006626	0.028957	0.027254	0.074954
Ideal Best V+	0.006626	0.028957	0.059239	0.092745
Ideal Worst V-	0.030305	0.011137	0.021173	0.056339

Source: Excel Output

Step 3 of the method result into Ideal best V+ and Ideal worst V –values given in Table 9 above, which were calculated through taking minimum and maximum values for all the criteria of signal type (high, false, medium and false) presented in weighted normalization matrix. Further these values are used for calculating Euclidean distance

(Si+ and Si-) for all the patterns presented in Table 10. Euclidean distance is Step 4 and Step 5 of method and helps to understand the relationship between cell and a particular source through a value presenting distance from individual cells in raster to nearest source.

Table 10: Euclidean Distance

Code	Si+	Si-
SL+	0.033131	0.033901
SL-	0.03989	0.032583
EN-	0.034059	0.027516
HR+	0.034024	0.026604
RW	0.032848	0.038505
LEB	0.033872	0.026897
FW	0.045843	0.019595
HR-	0.034006	0.031367
TU	0.028565	0.034189
LET	0.030114	0.031998
EN+	0.037806	0.024519
TD	0.034831	0.029992
TIU	0.046694	0.026458
TL+	0.033893	0.028331
TOW	0.04036	0.024304
OSS	0.043152	0.024689
HM	0.042362	0.022497
HP	0.04234	0.026304
TID	0.031779	0.032502
ND	0.027916	0.034258
HM	0.045957	0.020514
TL-	0.023741	0.040103

Code	Si+	Si-
BH-	0.032973	0.043331
TT	0.044152	0.025041
TL	0.038941	0.023205
TOU	0.019921	0.04331
TB	0.042378	0.038934
SD	0.035334	0.026211
DCC	0.0366	0.035521

Source: Excel Output

In the final step of TOPSIS method Euclidean values are used to calculate performance score of all patterns of candles followed by rank determination according to performance index values. With this the calculation the performance evaluation of all the listed candle patterns is

ended. Performance index statistically helps to determine the rank or order of participating options for this research work it is candle patterns through calculating likeness to the ideal solution. Performance score with relative ranking order for all listed candle patterns is presented in Table 11 below.

Table 11: Euclidean Distance

Pi	Rank	Code	Pattern Name
0.505742412	8	SL+	Strong Line+
0.449587864	15	SL-	Strong Line-
0.446865518	16	EN-	Engulfing-
0.438806321	18	HR+	Harami+
0.539638967	6	RW	Rising Window
0.442607567	17	LEB	Last Engulfing Bottom
0.299441489	29	FW	Falling Window
0.479816549	11	HR-	Harami-
0.544813029	5	TU	Turn Up
0.515169345	7	LET	Last Engulfing Top
0.393403452	20	EN+	Engulfing+
0.46267448	13	TD	Turn Down
0.361681047	26	TIU	Three Inside Up
0.45530697	14	TL+	Tasuki Line+
0.375852013	22	TOW	Three Outside Down
0.363923895	24	OSS	One-Candle Shooting Star
0.346856442	27	HM	Hanging Man
0.383196819	21	HP	Homing Pigeon
0.505630234	9	TID	Three Inside Down
0.551006316	4	ND	Northern Doji
0.308617169	28	HM	Hammer
0.628145118	2	TL-	Tasuki Line-
0.567869006	3	BH-	Belt Hold-
0.361901904	25	TT	Tweezers Top
0.373396831	23	TL	Takuri Line

Pi	Rank	Code	Pattern Name
0.684946587	1	TOU	Three Outside Up
0.478818734	12	TB	Tweezers Bottom
0.425882387	19	SD	Southern Doji
0.492522225	10	DCC	Dark Cloud Cover

Source: Excel Output

Higher performance index values signify closeness of performance value to the positive Euclidean distance derived positive ideal solution and distance from the negative Euclidean value. From the Table 10 it is identified that three outside up candle pattern has the best performance and predictability for the 5 days holding of the sampled stocks of banks namely State Bank of India, ICICI, Bank of Baroda, Industrial Development Bank of India, and HDFC. In this research, falling window candle pattern has the lowest performance and predictability among listed candle patterns. All the other candle patterns have consistent result for the performance and predictability for the 5 days holding of the sampled stocks of banks.

Conclusion

Nowadays, finance sector particularly investment avenue segment of the sector is the important one. The primary explanation for such advancement of the sector is the common persons' need and inclination towards investing for different financial and non-financial advancements. It is assumed that trend of investment in different avenues won't ever appear to back off as per the expanding deals and the requirements of different innovative investment avenues. Among all the available investment avenues one preferable avenue of investment is stock market, where risk is associated with the investment. So, predicting the future price of the stock and market movement is considerable and among different technical and fundamental methods of analysis, in this research work candlestick pattern analysis with followed application of TOPSIS for evaluating candle pattern performance is chosen for the study purpose. This research work presented systematic information for the use and effectiveness of candlestick technical analysis over 5 leading bank stocks (State Bank of India, ICICI, Bank of Baroda, Industrial Development Bank of India, and HDFC) of Bank Nifty for the period of 10 years from 2010 to 2020. Nature of candlestick based technical analysis is

quantitative which helped to predict the future price of the stock and market trend without transformation of the data into statistical plots of time series analysis. In this research work the performance and predictability of a candle pattern is recognized through the TOPSIS method over backtested consequences for 5-days holding. On the basis of TOPSIS performance indicator based ranking over the 29 candle patterns of 5 leading bank stocks, it was identified that three outside up (TOU), Belt Hold- (BH-), and Tasuki Line- (TL-) candle patterns are ranked on first three positions respectively among 29 different candle patterns. Operational scope of research work can be extended by incorporating different methods and criteria of rank and order determination. Trading on the basis of performance index determined through the returns with the stock specific method more close and robust results can be derived. It was also noticed while studying different candlestick patterns few of the patterns are loss making, few candlestick patterns are about average return patterns and approximately 50% of the candlestick patterns are exceptional yielding or profoundly productive in nature. Candle pattern based technical analysis a valuable trading instrument gave legitimate stop-loss determination technique to restrict the misfortunes; in this way, trading effectiveness could be significantly improved. Candlescanner software for candlestick pattern analysis and finding the statistical output for stock or certain group of stocks is efficient enough and helps in determining trading efficiency by offering tests over the stocks.

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