International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Evaluating and Forecasting rate of Counterfeit Banknote Detection

Akanksha Upadhyaya, Vinod Shokeen, Garima Srivastava

Abstract*: Detection of counterfeit banknotes becoming a major issue in today's scenario, as it is seems to be weighty aspect in terms of socio-economy of every living being. This paper highlights various distinguishing features of currencies of different countries, having an objective to secure their currency less susceptible from forgery. Afterwards, the paper focuses on analysing and comparing the rate of counterfeit detection with the forecasted rate of counterfeit currency detection. The analysis has been performed using, paired sample t-test and elementary time series forecasting in IBM SPSS 21 and RStudio respectively. Data points from 1999-00 to 2017-18 have been collected from Reserve Bank of India Annual reports under currency management section.

***Index Terms*: Counterfeiting, Banknotes, Data forgery, Currency, paired sample t-test, Holt-Winters, time series forecasting, currency management, Reserve Bank of India, security features, outliers, normality..**

I. INTRODUCTION

In ancient time after barter system coins were introduced as common medium of exchange and hence from that time providing security to currency has been a long ago practice. In 449-413 BC test cuts were engraved on the coins to check the quality of base metals [1]. Afterwards when paper currency was introduced, Great Britain was the first country to patent first security feature as Security metallic thread but the particular feature was deviced in currency 100 years later. Later on many security features such as intaglio printing, watermark, micro printing, security inks etc. has been incorporated by different country to secure their currency [2]. Even after a large number of security features counterfeiting remains a problem for every country. Counterfeiting is a term that refers to creation of exact replicas of genuine entity. The practice of currency counterfeiting has been continued from ancient time. It has been always an alarming term for any nation because it creates currency devaluation and thereby inflation [3]. With the increase in number of counterfeit banknote Reserve Bank of India in the year 2008-09 made it mandatory to implement Note Sorting Machines in bank chest branches that leads to increase in number of counterfeit banknote detection.

Revised Manuscript Received on 30 July 2019.
* Correspondence Author
Akanksha Upadhyaya, AIIT, Amity University, Noida, (RDIAS), India.
Vinod Shokeen, AIARS, Amity University, Noida, India.
Garima Srivastava, CS/IT, DRKNMIET, Ghaziabad, India.

The Reserve Bank of India, India, statutory body published a report, RBI/2009-10/228, on November 2009, about authenticity or fitness of banknote. To prevent the modern currency from the threat of forgery is to keep updated with contemporary technology and periodic revision in security features. It has been revealed in the report that ensuring genuine banknotes in circulation is due to the use of appropriate Note Sorting Machines in bank chest branches [4]. As per annual statistics published by Reserve Bank of India about counterfeit banknote detection in proportion to total banknotes in circulation, the number of counterfeit currency detection was averagely 37% and it was improved to 71% after introduction of technology in terms of Note Sorting Machine in bank chest branches [5]. A hefty difference of 34% has significantly improved the rate of counterfeit banknote detection in recent years. Note sorting machines detects the genuinity of currency by checking the standard security features. Table 1 represents various security features incorporated by different country. The details about currency security features have been taken from various reliable sources such as central banks or financial institution of various countries. Furthermore, an analysis on number of counterfeit banknote detection in proportion to total banknote in circulation has been also examined using paired sample T-test and elementary time-series analysis.

II. RELATED WORK

Currency counterfeiting is one of the dominating areas where focus should be given to detect the currency integrity as per the standards. Various security features has been incorporated and periodically updated by different country to make their currency invulnerable from serious attacks. Various researchers came with variety of solution to make the currency invulnerable from counterfeit attacks. [18] has reviewed and evaluated security features of six countries and concluded that Indian currency has utmost security features and a special anti-photocopying feature known as "Omron". Using color feature and texture feature vector [19] proposed a prototype using empirical approach. Furthermore, the suspected banknote from genuine one has been classified using Feedforward Neural Network. [20] narrated a validation system for Indian currency notes Identification. The system is implemented using SIFT Technique that helps in systematic matching of Bank note features. Furthermore, various methods, systems, framework has been designed in [21-23] using different methodology. Some of them have used MATLAB for feature extraction with HSV Color space, and

some has implemented their system using Artificial Neural Network. [24] Described a proposed system based on hardware as well as software components for counterfeit detection of Euro banknotes. The system has been tested and validated on a dataset provided by Italy's central bank. [25] Report depicts the result of counterfeit detection from 2006-2008, currency management operations conducted by RBI and also the steps taken by RBI to restraint currency counterfeiting. Consequently, it can be illustrated that even after Zero tolerance policy for counterfeiting integrity assurance of banknotes must be effectively improved and for this various methods, systems and solutions has been lay down. Every proposed technique or the model was followed by feature extraction and then machine learning techniques. A handful of proposed contributions statistically analysed & discussed about need of the current research along with its prolonged scenario. Therefore, the current research aims to identify, analyse and compare the scenario of counterfeit banknote detection with future rate of detection so as to realize the prolonged purview of the banknote-counterfeiting problem. The research has been conducted with special reference to India and will help in recognizing gravity of problem. Additionally time series analysis has been also performed to foresee the sufficiency of current measures, technology and security features from counterfeiting of banknotes.

	Indian Rupees	**Australia Dollar**	**Canadian Dollar**	**European Euro**	**Hong Kong SAR**	**Japanese Yen**	**Singapore Dollar**	**Swedish Krona**	**Swiss Franc**	**UK Pound**	**US Dollar**
Intaglio Printing	√	√	√	√	√	√	√	√	√	x	x
See through	√	√	√	√	√	x	x	x	x	x	x
Watermark	√	x	√	√	√	√	√	√	√	√	√
Microprinting	√	√	√	√	x	√	x	x	x	x	√
Microlettering	√	x	x	x	x	x	x	√	x	√	x
Hologram	x	x	x	√	x	√	x	x	x	√	x
Thread	√	x	√	√	√	x	√	√	x	√	√
Security Inks	√	√	√	x	√	√	√	√	√	x	√
Ultra-violet test feature	√	√	√	√	√	x	√	x	x	√	√
Denomination value mark	√	√	√	√	√	√	√	√	√	√	√
Latent Image	√	x	x	x	x	√	x	x	x	x	x
Anti-photocopying feature	√	x	x	x	x	x	x	x	x	x	x
Different size for different denomination	√	√	√	√	√	√	√	√	√	√	√

Different colors for different denomination	√	√	√	√	√	√	√	√	√	√	√
Serial Number	√	x	√	x	√	x	x	x	√	x	x
Mark for Blind	√	√	√	√	√	√	√	√	√	√	√
Unique feature	Anti-photo-copying	Clear Window	Mettalic portrait and mettalic symbols	Perforation	Designed coloured patterns in front and back	Latent pearl image	Kinegram	Motion	Iriodin digits and Kinegram	Foil patch Motion thread	3-D security ribbon Bell in ink

III. RESEARCH OBJECTIVES

Based on the gaps identified through past research the following objectives have been framed for statistical analysis of counterfeit banknote detection with special reference to India:

i. To analyse the rate of counterfeit currency detection after introduction of NSM in banks

ii. To forecast the rate of counterfeit currency detection in proportion to total banknote in circulation.

iii. To analyse the current rate of counterfeit currency detection with forecasted rate of counterfeit currency detection.

IV. RESEARCH METHODOLOGY

In the light of accomplishing mentioned objectives the research methodology of current research has been carried out in different phases. To carry out current research, hypothesis testing and elementary time-series analysis has been performed. The dataset has been collected from RBI annual reports [5]. The dataset comprised of total banknotes in circulation and counterfeited banknotes detected each year. Paired sample T-test has been applied for hypothesis testing with respect to objective i & iii and time series forecasting has been performed to forecast the rate of detection for next 10 years with respect to objective ii using IBM SPSS 21 and RStudio respectively. Both test requires fulfillment of their respective assumptions on dataset. These assumptions are discussed further in the same section. The continuous improvement in detection rate is the need of an hour because it directly hits nation's economy. With this perspective, following hypothesis has been framed based on the research objectives i and iii.

H1: There is no significant difference in rate of counterfeit detection after introduction of Note Sorting Machines in bank chest branches.

H2: There is no significant difference in the current rate of counterfeit detection with the forecasted rate of counterfeit detection.

V. ANALYSING RATE OF COUNTERFEIT CURRENCY DETECTION

As a part of objective i defined under section 3, assumptions have been tested for paired sample T-test on the data points collected from Reserve bank of India using IBM SPSS 21

A. *Pre-testing using assumptions*

Few of the assumptions have been tested before actual implementation of paired sample T-test [27] for hypothesis testing and Holt Winters function for elementary time series forecasting [28].

Assumption 1: The dependent variable must be continuous.

Table 2- Year-wise Counterfeit banknotes detected [5]

Year (April-March)	Counterfeit Banknotes detected	Total Bank notes in circulation(in lacs)
1999-00	37523	325339
2000-01	102687	357040
2001-02	124515	383380
2002-03	211754	373090
2003-04	205266	383360
2004-05	181928	369840
2005-06	123917	378510
2006-07	104744	3,98,310
2007-08	195811	442250
2008-09	398111	4,89,630
2009-10	401476	565490
2010-11	435607	6,45,770
2011-12	521155	693840
2012-13	498252	7,35,170
2013-14	488273	773300
2014-15	594446	8,35,790
2015-16	632926	902660
2016-17	762072	1002930

Since the values of dependent variable shown in table 2 i.e. Counterfeit banknotes detected each year holds continuous value, therefore this assumption holds true.

Assumption 2: The dependent variable, which is the difference between counterfeit banknotes detected before introduction of NSM i.e. 2008-09 and counterfeit bank notes detected after introduction of NSM i.e. 2008-09 should be approximately normally distributed.
Null Hypothesis H0: The sample is normally distributed

Table 3- Counterfeit banknote detected before and after 2007-08 [5]

Before introduction of NSM	After introduction of NSM	Difference
37,523	3,98,111	3,60,588
1,02,687	4,01,476	2,98,789
1,24,515	4,35,607	3,11,092
2,11,754	5,21,155	3,09,401
2,05,266	4,98,252	2,92,986
1,81,928	4,88,273	3,06,345
1,23,917	5,94,446	4,70,529
1,04,744	6,32,926	5,28,182
1,95,811	7,62,072	5,66,261

The values given under Difference column represented under table 3 has been tested. For sample size less than 50 Shapiro-Wilk Test has been applied [30, 31], as shown in table 4. Sig value (p-value) has been checked to see whether the values in dependent variable are normally distributed [29]. Since the sig value is greater than 0.05, therefore, Null Hypothesis (H0) is accepted [27], which shows that sample is normally distributed.

Table 4- Shapiro Wilk test for normality

	Sig
Difference	.569

Assumption 3: The dependent variable which is the difference between counterfeit banknotes detected before 2008-09 and counterfeit bank notes after 2008-09 should not contain any outliers.

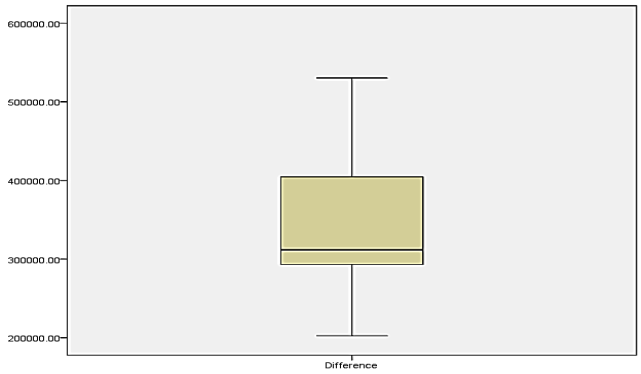

Fig 1. Box plot for outlier detection

Outlier represents extreme value in the sample. To check outliers in the sample indicated in table 3, boxplots has been created as shown in fig 1. Since No value outside the upper and lower whisker therefore, this assumption also holds true.

VI. FORECASTING RATE OF COUNTERFEIT CURRENCY DETECTION

As a part of objective ii defined under section 3, assumptions have been tested for Holt-Winters time series forecasting on the data points collected from Reserve bank of India using RStudio.

Assumption 1: Checking the data for seasonality and trend.

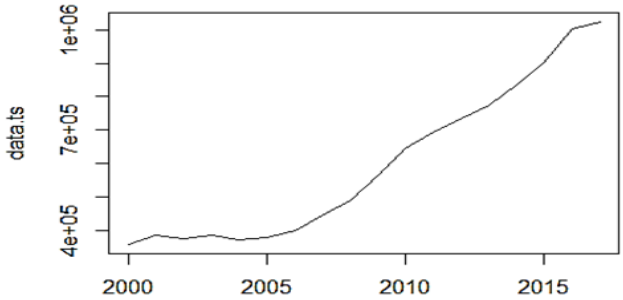

Fig 2. Checking seasonality and trend in Total Banknotes in circulation

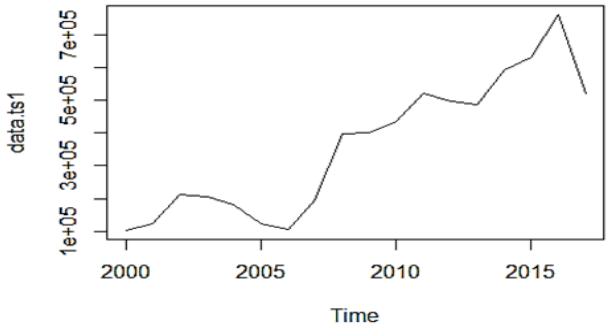

Fig 3. Checking seasonality and trend in no. of counterfeit banknotes detected

The data shown in table 2 has been considered for checking seasonality and trend in the dataset. Since both i.e. Banknotes in circulation each year and counterfeited banknotes detected each year shows an upward trend but no seasonality in the sample, represented in fig 2 and 3 respectively, therefore, such a method is required which can fit non-seasonal data for forecasting the rate of counterfeit currency detection in proportion to banknotes in circulation each year.

VII. COMPARING CURRENT RATE OF COUNTERFEIT CURRENCY DETECTION WITH FORECASTED RATE OF COUNTERFEIT CURRENCY DETECTION

As a part of objective iii defined under section 3, assumptions have been tested for paired sample T-test [27] on the data points collected from Reserve bank of India [5] and the 10 data points forecasted in objective ii using IBM SPSS 21.

Assumption 1: The dependent variable must be continuous.

Table 5- Present vas forecasted number of Counterfeit banknotes detected

Current years	Current Counterfeit Banknotes detected (in pieces/volume)	Forecasted Year	Forecasted Counterfeit Banknotes detected (in pieces/volume)
2008	195811	2018	623183
2009	398111	2019	645011
2010	401476	2020	666839
2011	435607	2021	688667
2012	521155	2022	710495
2013	498252	2023	732323
2014	488273	2024	754151
2015	594446	2025	775979
2016	632926	2026	797807
2017	762072	2027	819635

Since the values of dependent variable, shown in table 6, i.e. counterfeit banknotes detected and forecasted banknotes detected holds continuous value, therefore this assumption holds true.

Assumption 2: The dependent variable which is the difference between counterfeited banknotes detected and forecasted counterfeit banknotes detected should be approximately normally distributed.

Null Hypothesis H0: The difference between counterfeited banknotes detected and predicted counterfeited bank notes detected is normally distributed.

Table 6- Counterfeit banknotes detected before and after 2016-17

Current years	Current Counterfeit Banknotes detected (in pieces/volume)	Forecasted Year	Forecasted Counterfeit Banknotes detected (in pieces/volume)	Difference
2008	195811	2018	623183	427372
2009	398111	2019	645011	246900
2010	401476	2020	666839	265363
2011	435607	2021	688667	253060
2012	521155	2022	710495	189340
2013	498252	2023	732323	234071
2014	488273	2024	754151	265878
2015	594446	2025	775979	181533
2016	632926	2026	797807	164881
2017	762072	2027	819635	57563

For sample size less than 50 Shapiro-Wilk Test has been used [30,31], as shown in table 7. Sig value (p-value) has been checked to see whether the values in dependent variable are normally distributed [29]. Since the sig value is greater than 0.05, therefore, Null Hypothesis (H0) is accepted [27], which shows that sample is normally distributed.

Table 7- Shapiro Wilk test for normality

	Sig
Difference	.353

Assumption 3: The dependent variable which is the difference between counterfeited banknotes detected and predicted counterfeited bank notes should not contain any outliers.

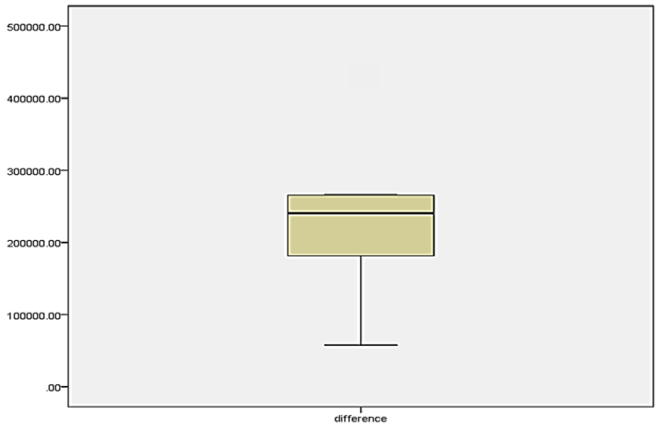

Fig 4. Box plot for outlier detection

Outlier represents extreme value in the sample. To check outliers in the sample indicated in table 6 boxplot has been created, as shown in fig. 4. Since no value outside the upper and lower whisker therefore, this assumption also holds true.

VIII. RESULTS & DISCUSSION

Objective wise analysis has been performed after validating the assumptions of paired sample T-test and Holt-Winters time series forecasting in section 4.

A. *Analysing rate of counterfeit currency detection:*

The hypothesis testing has been performed to validate the reason of increase in counterfeit detection since the year 2008-09 onwards. The chart shown in fig. 6 is made using MS-Excel and the data shown in Table 2 has been considered. Paired sample T-test has been performed using data represented in table 3. An increase in rate of counterfeit currency detection is due to the due to the introduction of Note Sorting Machines (NSM) at the currency chest branches of banks [4]. The reason has been validated with the help hypothesis testing using paired sample T-test in IBM SPSS:

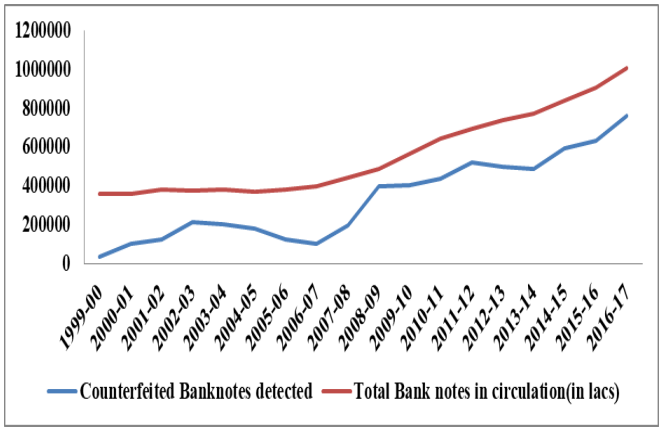

Fig 5. Counterfeit banknotes detected in proportion to total banknotes in circulation

Table 8- Year wise Counterfeit Detection

Year (April-March)	Year wise counterfeit currency detection (%)	Cumulative Difference (%)
1999-00	11%	18%
2000-01	29%	
2001-02	32%	4%
2002-03	57%	24%
2003-04	54%	-3%
2004-05	49%	-4%
2005-06	33%	-16%
2006-07	26%	-6%
2007-08	44%	18%
2008-09	81%	37%
2009-10	71%	-10%
2010-11	67%	-4%
2011-12	75%	8%
2012-13	68%	-7%
2013-14	63%	-5%
2014-15	71%	8%
2015-16	70%	-1%
2016-17	76%	6%

Table 8 shows percentage of year wise counterfeit detection and shown in Fig 5, it can be easily summarized that in the year 2008-09 maximum counterfeited banknotes has been detected. The reason for this maximum growth is that, RBI made a requisite to all currency chest branches of banks for the introduction of Note Sorting Machines (NSM). Formation of Vigilance cell for investigating the causes of forgery also helped in detection of counterfeit bank notes.

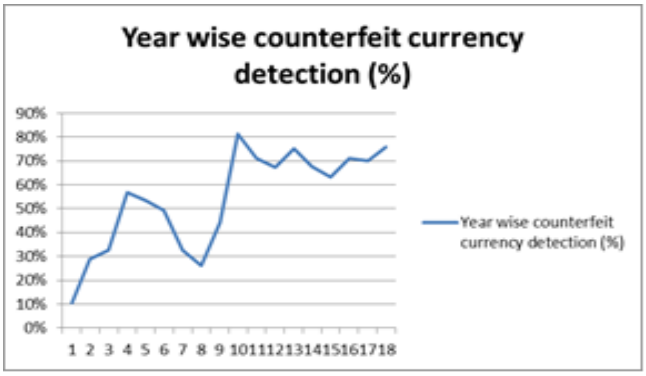

Fig 6 Year wise percentage growth in counterfeiting

Paired sample T-test Result represented in Table 9 shows that Null Hypothesis in this case cannot be accepted because sig value is less than 0.05 [27]. Therefore, it can be concluded that there is a significant difference in the rate of counterfeit currency detection after the introduction of Note Sorting Machines at the currency chest branches.

Table 9- T-Test: Paired Two Samples for Means before and after 2008-09

Pair 1	**Before2008-09 - After2008-09**
Lower	-468560.298
Upper	-225700.369
t	-6.592
df	8
Sig. (2-tailed)	.000

B.*Forecasting rate of counterfeit currency detection:*

Holt-Winters proposed a model of time series behaviour. The function predicts the future value by combining effects of three parameters; alpha, beta, gamma. Holt-Winters is a way to model three aspects of time series: Average (alpha), slope /trend (beta) and cyclical repeating patters/seasonality (gamma) and can be applied for Non-seasonal data [28]. To predict the total banknotes in circulation and rate of counterfeit currency detection in next decade the value of gamma is set to FALSE [28]. The table 10 represents forecasted value of Total banknotes in circulation and number of counterfeit banknotes in circulation in next 10 years.

```
#install.packages("rmarkdown")
#install.packages("rmarkdown")
library(rmarkdown)
library(data.table)
library(forecast)
library(tseries)
```

#Forecasting total Banknote in circulation in next 10 years

```
#Reading the data
data<-fread("C:\\Users\\647531\\Desktop\\data_time series.csv")
#Removing comma in between the numbers
data$`bank notes in circulation(million pieces/volume)` <-
  as.numeric(gsub(",","",data$`bank notes in circulation(million pieces/volume)`))
data$`Counterfeited Banknotes detected (in pieces/volume)`<-
  as.numeric(gsub(",","",data$`Counterfeited Banknotes detected (in pieces/volume)`))
```

#Converting data into time series using TS function

```
data.ts<-ts(data$`bank notes in circulation(million pieces/volume)`, frequency=1,start = c(2000))
data.ts
## Time Series:
## Start = 2000
## End = 2017
## Frequency = 1
##  [1]  357040  383380  373090  383360  369840  378510  398310  442250
```

```
## [9] 489630 565490 645770 693840 735170 773300 835790 902660
## [17] 1002930 1023950
#Plotting the time series
plot(data.ts)
series1<-HoltWinters(data.ts,gamma=FALSE)
forecast_series1 <- forecast(series1, h=10)
forecast_series1
```

#Forecasting No. of counterfeit banknotes detected in next 10 years

```
data.ts1<- ts(data$`Counterfeited Banknotes detected (in pieces/volume)`, frequency=1,start = c(2000), end = c(2017))
data.ts1
## Time Series:
## Start = 2000
## End = 2017
## Frequency = 1
## [1] 102687 124515 211754 205266 181928 123917 104744 195811 398111 401476
## [11] 435607 521155 498252 488273 594446 632926 762072 522783
plot(data.ts1)
series2<-HoltWinters(data.ts1,gamma=FALSE)
forecast_series2 <- forecast(series2, h=10)
forecast_series2
```

Following values represented in table 10have been retrieved with the help of Holt-Winters function implementation in R Studio:

Table 10- Forecasted values of No. of counterfeit banknotes detected and total banknotes in circulation

Predicted Year	Forecasted No. of Counterfeit Bank notes detected (in pieces/volume)	Forecasted Total Bank notes in circulation (million pieces/volume)
2018	623183	1071736
2019	645011	1119522
2020	666839	1167308
2021	688667	1215095
2022	710495	1262881
2023	732323	1310667
2024	754151	1358453
2025	775979	1406239
2026	797807	1454025
2027	819635	1501811

C.*Comparing current rate of counterfeit currency detection with forecasted rate of counterfeit currency detection:*

The hypothesis testing has been performed to test the difference in current rate of counterfeit currency detection with forecasted rate of counterfeit bank note detection in proportion to Total Banknote in circulation. To validate whether there exist a significant difference or not, Paired sample T-test has been applied [27]. The chart shown in fig.6 represents the rate of counterfeit currency detection in proportion to Total banknote in circulation in next 10 years. The data shown in table 5 has been considered for building line chart.

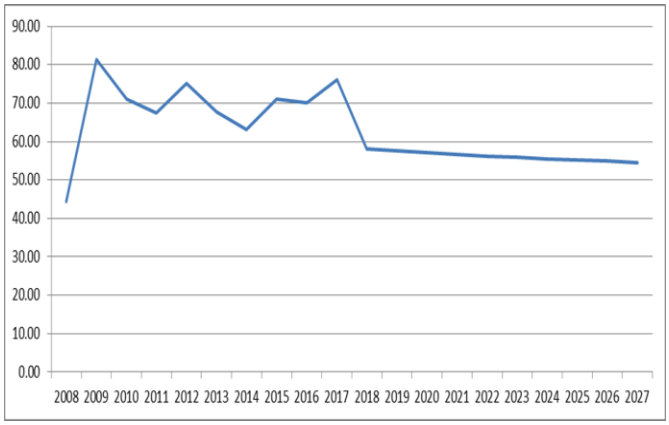

Fig 7. Rate of counterfeit banknote detection in proportion to total banknotes in circulation (2008-09 to 2026-27)

To test the current rate of counterfeit banknote detection with forecasted rate of counterfeit banknote detection paired sample t-test has been applied on the dataset represented in table 5 and results are shown in table 11.

Table 11- T-Test: Paired Two Samples for Means

Pair 1	Before and After 2017-18
Lower	161031.573
Upper	296160.627
t	7.654
df	9
Sig. (2-tailed)	.000

Paired sample T-test result represented in table 11 shows that Null Hypothesis cannot be accepted because sig value is less than 0.05 [27]. Therefore, it can be concluded that there is a significant difference in the current rate of counterfeit banknote detection with forecasted rate of counterfeit banknote detected. In other words, if we closely look into the trend of rate of counterfeit banknote detection then it is found that in next decade i.e. for forecasted years, the rate of detection will be almost constant each year and showing a downward trend in comparison to last 10 years, as shown in Fig 6.

IX. CONCLUSION AND FUTURE SCOPE

The present research is an effort to provide statistical evaluation of counterfeit banknote detection. Overall, from the research it is revealed that there is a continuous need to revise measures and technology so that the banknote counterfeiting problem can be eradicated. Moreover, the present research confers various relative features of different currencies. It is found that every currency has its unique feature that make their currency invulnerable from forgery attacks. Even after carving many features, malicious counterfeit attackers are successful in imitation. After analyses done on the Indian Rupee it is found that from 2008-09 the currency counterfeit detection has been improved in comparison to previous years and also the major cause of

such improvement is due to the introduction of NSM in all currency bank chests of India. Furthermore, forecasting for next 10 years revealed that rate of counterfeit detection will be constant as well as showing downward trend when compared with current years. Therefore, the current research work can be advanced by proposing some predictive model or framework that could accurately classify genuine banknotes from forged bank notes. Furthermore, any technique could be proposed for improvement of Note Sorting Machines that will improve the rate of counterfeit detection.

REFERENCES

1. Carothers, N. Fractional money: A history of the small coins and fractional paper currency of the United States. AM Kelley, 1930
2. Standish, D., Armour, T., & Dunn, J. The art of money: The history and design of paper currency from around the world. San Francisco: Chronicle Books, 2000
3. Bloom, M. T. (1982). Money of Their Own: The True Stories of the World's Greatest Counterfeiters (p. 100). BNR Press.
4. RBINotification,https://m.rbi.org.in/Scripts/Notification, User.aspx?Id=5376&Mode=0, Accessed on September 10, 2016.
5. RBI Annual Report, Currency Management, https://www.rbi.org.in/scripts/AnnualReportPublications.aspx ? Id=574 (1999-2017), Accessed on October 2018
6. Security features, http://stevenbron.nl/security-features, Accesed on July 17, 2016
7. Indian currency security features, http://www.rbi.org.in/ currency/security%20feature s.html, Accesed on July 17, 2016
8. American Dollar security features, www. secretservice.gov, Accesed on July 20, 2016
9. Bureau of Engraving and Printing-U.S. Department of the Treasury, www.moneyfactory.gov 5. Genuine US currency production, security features and counterfeiting, Ken huffler, SAIC-Phoenix field office, United States secret service, Accesed on July 23, 2016
10. Recent trends in counterfeiting, Arianna Cowling, note issue department, Reserve Bank of Australia, Accesed on July 23, 2016
11. Banknote features, http://banknotes.rba.gov.au/ securityfeatures.html, Accesed on July 27, 2016
12. Current banknotes, http://www.bankofengland. co.uk/banknotes/pages/current /default.aspx, Accesed on July 27, 2016
13. Quick guides of the security features of Euro banknote European central Bank, Accesed on August 03, 2016
14. Security features, http://www.ecb.europa.eu/ euro/ banknotes/ security/html/i ndex.en.html, Accesed on August 03, 2016
15. Euro banknotes- security features, http://www.new-eurobanknotes.eu/Euro-Banknotes/Securityfeatures /FEEL/THE-FIRST-SERIES-%E2%82%AC5, August 03, 2016
16. Security features of Hong Kong's currency notes, http://www.hkma.gov.hk/eng/classroom/page/notescoins/security.htm, August 03, 2016
17. Security Features of the New Bank of Japan Notes, https://www.boj.or.jp/en/note_tfjgs/note/security/bnnew3.htm/, August 03, 2016.
18. Mann Manisha, Shukla S.K.,Gupta Shruti "A comparative study on security features of banknotes of various countries"International Journal of Multidisciplinary Research and Development (83-91) Volume: 2, Issue: 6, June 2015.
19. Q. Yan Wei, Chambers J, Garhwal A, "An empirical approach for currency identification", Springer Multimedia Tools Appl, January 2014.
20. Kavya B R, Devendran B, "Indian currency detection and denomination using sift" International Journal of Science, EngineeringInternational Journal of Engineering Science and Innovative Technology (IJESIT) (560-566), Volume 3, Issue 4, July 2014.
21. YadavBinod Prasad. Patil C. S,Karhe R.R, Patil P.H "An automatic recognition of fake Indian paper currency note using MATLAB" and Technology Research (IJSETR) (1909-1911), Volume 4, Issue 6, June 2015.
22. Thakur Megha, KaurAmrit, "Various fake currency detection techniques", International Journal For Technological Research In Engineering (1309-1313), Volume 1, Issue 11, July-2014
23. MohamadNurSyuhada, HussinBurairah, Shibghatullah A.S.,BasariA.S.H, "Banknote authentication using artificial neural network", International Symposium on Research in Innovation and Sustainability 2014 (ISoRIS'14) 15-16 October 2014, Malacca, Malaysia, Sci.Int.(Lahore),26(5),1865-1868,2014
24. KapareDhirajVasant, LokhandeSadashiv, Kale Sayaji, "Automatic Cash Deposite Machine With Currency Detection Using Fluorescent And UV Light", International Journal Of Computational Engineering Research (ijceronline.com) (309-311) Vol. 3 Issue. 3, March-2013
25. Arcangelo Bruna,Giovanni Maria Farinella,Giuseppe Claudio Guarnera,Sebastiano Battiato,"Forgery Detection and Value Identification of Euro Banknotes", MDPI Open Access, February-2013, http://www.ncbi.nlm.nih.gov/pmc /articles/ PMC364 9387
26. Satish K, ViswanadhamY.K, LeelaPriyaI, "Money to ATM – Fake Currency Detection", International Journal of Computer Science and Information Technologies (IJCSIT), Vol. 3 (5), 2012, 5046-5050
27. Zimmerman, D. W. (1997). Teacher's corner: A note on interpretation of the paired-samples t test. Journal of Educational and Behavioral Statistics, 22(3), 349-360.
28. Makridakis, S., S. Weelwright and R. Hyndman, "Forecasting: Methods and Applications", New York, USA: John Wiley & Sons, 1998.
29. Ghasemi, A., & Zahediasl, S., "Normality tests for statistical analysis: a guide for non-statisticians", International Journal of Endocrinology and Metabolism, 10(2), p 486, 2012.
30. Shapiro, S. S., Wilk, M. B., & Chen, H. J., "A comparative study of various tests for normality", Journal of the American Statistical Association, 63(324), pp 1343–1372, 1968.
31. Shapiro, S. S., & Wilk, M. B., "An analysis of variance test for normality", (complete samples). Biometrika , 52(3/4), pp 591–611, 1965.
32. Rice, W. R., "Analyzing tables of statistical tests. Evolution", 43(1), pp 223-225, 1989.

AUTHORS PROFILE

Akanksha Bhardwaj is a Research Scholar and pursuing her Ph.D. in Information Technology from Amity University, Noida. She has 10 years of teaching experience in the field of computer science and information technology and currently working as Assistant Professor in Rukmini Devi Institute of Advanced Studies. She made her publications in IEEE Xplore, Springer Procedia, Scopous indexed conferences, Inderscience Journal, IGI Global, and various other reputed international journals.

Vinod Shokeen is working as the head of the department of Electronics & Communication Engineering, at Amity University. He received his PhD degree in Electronics & Communication Engineering in 2011, from Delhi University in 2006. He is a member of the paper moderation board. He has made more than 15 Scopus Indexed publications. His research interests include network communication and cloud computing.

Garima Srivastava has 10 years of teaching experience. She had worked as Project Manager and faculty in WUST, Shandong, China for 2 years. She worked on Decision Support System for flood & earthquake analysis and Education analysis. She received her Ph.D in Computer Science from MNIT, Allahabad in the year 2015. Her area of interest includes decision support systems, image processing, and GIS. She has published more than 12 papers in reputed journals and for Scopus conferences.