International Journal of Advanced Multidisciplinary Research and Educational Development
Volume 1, Issue 4 | November - December 2025 | www.ijamred.com
ISSN: 3107-6513

Statistics of Election Integrity: Insights from Delhi Assembly Results

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***Abstract*— Election integrity is essential for democratic governance and demands objective, data-driven methods to assess the credibility of electoral outcomes. This study applies Benford's Law, a statistical tool used in forensic analysis, to examine the vote count distribution in the Delhi Assembly Elections. The Chi-square goodness-of-fit test was used to compare observed digit frequencies with the expected Benford distribution. The results reveal significant deviations (p-value < 0.05), suggesting possible irregularities. However, statistical deviations alone do not confirm electoral fraud; such deviations may arise from campaign strategies, demographic trends, regional political behavior, or structural limitations of Benford's Law itself. The study also considers broader political and technical criticisms, including concerns raised by political parties and doubts about the reliability of Electronic Voting Machines (EVMs). Given the global use of Benford's Law in election forensics, its application in the Indian context provides an evidence-based method to address public skepticism. This research highlights the value of statistical tools in strengthening electoral transparency and promoting data literacy in democratic systems.**

Keywords*— Benford's Law, Election Forensics, Chi-square Test, Electoral Integrity, Vote Count Analysis, EVM Criticism, Political Analysis, Data Literacy

1. INTRODUCTION

Elections are the foundation of a democratic society, ensuring fair representation and public trust in governance. However, over the years, concerns regarding the credibility and transparency of elections in India have grown significantly. Allegations of vote tampering, manipulation of Electronic Voting Machines (EVMs), irregularities in voter lists, and lack of transparency in the electoral process have raised doubts in the minds of voters and political stakeholders.

In this context, there is an increasing need for scientific and objective tools to assess electoral integrity. One such tool is Benford's Law, also known as the First Digit Law, which provides a statistical framework for analyzing the distribution of digits in naturally occurring datasets. It is widely used in forensic accounting, auditing, and fraud detection.

Benford's Law has also been applied to election data across the world. Notable examples include its use in examining the 2009 Iranian Presidential Elections, 2011 Russian Parliamentary Elections, and the 2004 and 2016 U.S. Presidential Elections. These applications have helped detect anomalies and initiate further investigations.

Given such global precedence, it is both logical and relevant to apply Benford's Law in the Indian electoral context. This study attempts to analyze vote count data from the Delhi Assembly Elections using Benford's Law, with the objective of examining whether the digit distribution in vote counts follows natural statistical patterns or shows signs of irregularities. Through this analysis, the study aims to explore the scope of statistical tools in strengthening democratic processes and promoting data literacy in electoral studies.

2. POLITICAL AND TECHNICAL CRITICISMS

In recent years, various political parties and leaders have expressed concerns about the transparency and fairness of the electoral process in India. Common objections include irregularities in vote counting, inconsistencies in voter lists, and doubts regarding the integrity of Electronic Voting Machines (EVMs). Several parties have demanded greater scrutiny of the election process and questioned the impartiality of results. EVMs, in particular, have drawn criticism regarding the possibility of tampering, the lack of end-to-end transparency, and the inability of independent bodies to verify their internal functioning. In some instances, discrepancies between EVM and VVPAT (Voter Verified Paper Audit Trail) counts have added to the skepticism. Critics often describe EVMs as "black box systems" where the internal mechanisms are opaque to the public. While the Election Commission of India maintains that EVMs are secure and tamper-proof, and various court rulings have upheld their usage, skepticism remains among certain political and civil groups. However, political and technical criticisms alone are insufficient to conclude electoral fraud. Such criticisms, though important to acknowledge, require evidence-based evaluation. In this context, statistical tools such as Benford's Law provide a neutral, objective, and scientific framework to assess the naturalness of vote distributions. These methods offer empirical responses to subjective doubts and help determine whether observed voting patterns are truly irregular or consistent with expected norms. Therefore, using such statistical tools is an appropriate and rational approach to address electoral concerns and reinforce democratic trust.

3. BENFORD'S LAW: DEFINITION AND APPLICATIONS

Benford's Law has been successfully used in several countries for analyzing election data. If such a tool can be applied in countries like Iran, Russia, and the United States, it is both logical and relevant to apply it in the Indian electoral context as well. Before proceeding with its application in this study, it is essential to understand the theoretical basis of Benford's Law and review where it has been effectively used in practice.

3.1 Definition of Benford's Law

Benford's Law, also known as the First-Digit Law, is a statistical principle that describes the expected distribution of leading digits in naturally occurring datasets. According to this law, lower digits such as 1, 2, and 3 occur more frequently as the leading digits than higher digits like 8 or 9. The probability of a digit d (from 1 to 9) appearing as the first digit is given by the logarithmic formula:

$P(d)= \log_{10}(1+1/d)$

This results in the following expected frequencies:

First Digit	Expected Frequency (%)
1	30.1
2	17.6
3	12.5
4	9.7
5	7.9
6	6.7
7	5.8
8	5.1
9	4.6

Benford's Law is particularly applicable to datasets that span multiple magnitudes and are not artificially constrained. Its statistical consistency makes it a powerful tool for detecting anomalies.

3.2 Common Applications of Benford's Law

Benford's Law has been widely used in various fields, especially where detection of anomalies or inconsistencies is crucial. Some common applications include:

- Forensic accounting and financial audits
- Tax fraud detection
- Census and demographic data verification
- Scientific data validation
- Election forensics and voting pattern analysis

In the context of elections, Benford's Law has been applied globally to detect irregularities in vote counts. Notable examples include:

- **2009 Iranian Presidential Elections** – statistical deviations raised concerns about possible manipulation.
- **2011 Russian Parliamentary Elections** – used by analysts to identify suspicious digit patterns.
- **2004 and 2016 U.S. Presidential Elections** – applied by independent researchers to study vote distributions and raise discussions about data integrity.

These cases demonstrate that Benford's Law can be a valuable tool in electoral analysis, offering a scientific framework to assess whether voting data aligns with expected natural patterns or displays signs of possible manipulation

4. METHODOLOGY

This section describes the data collection procedures and the statistical techniques employed to examine whether the vote count data from the Delhi Assembly Elections conforms to Benford's Law.

4.1 Data Collection

The dataset used in this study comprises the vote counts received by 880 candidates across 70 constituencies in the Delhi Assembly Elections. The data was obtained from the official records published by the Election Commission of India (ECI). For each candidate, the first digit of the vote count was extracted to examine its frequency distribution. A frequency table was prepared to compare the observed distribution of the first digits (1 to 9) with the expected distribution as per Benford's Law.

4.2 Statistical Technique

To evaluate whether the observed distribution of first digits significantly deviates from the expected Benford distribution, a **Chi-square test** was conducted. This test compares the observed and expected frequencies of the digits to determine whether the deviations are statistically significant.

The Chi-square statistic is calculated using the formula:

$\chi 2=\sum(Oi-Ei)2/Ei$

Where:

- Oi = Observed frequency of ithdigit
- Ei = Expected frequency of ith digit based on Benford's Law

A **p-value of less than 0.05** is considered statistically significant, indicating that the observed digit distribution does not align with the expected natural pattern.

Observed vs Expected Frequencies Table

First Digit	Observed Frequency	Expected Frequency
1	250	264.88
2	195	154.88
3	125	110
4	99	85.36
5	78	69.52
6	51	58.96
7	42	51.04
8	36	44.88
9	24	40.48

Chi-Square Test Results

The results were analyzed using the Chi-square goodness-of-fit test:

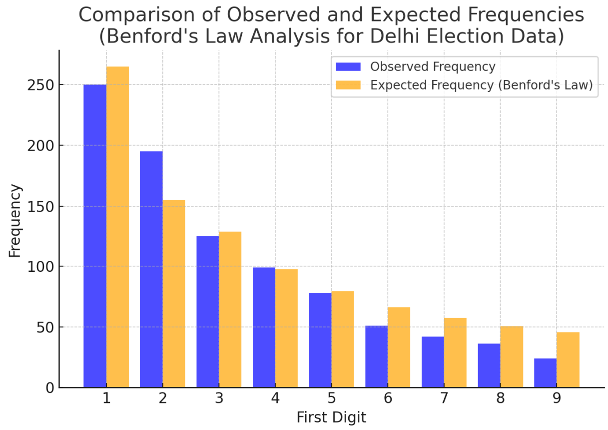
- **Chi-square statistic = 27.50**
- **Degrees of Freedom = 8**
- **p-value < 0.05**

This statistical test indicates a significant difference between observed and expected frequencies. This means that the number distribution does not match Benford's Law perfectly. However, such statistical deviations do not automatically indicate electoral fraud. Several contextual factors may explain these variations, such as:

1. **Political Campaign Strategies** – The number of votes received by specific candidates may depend more on political strategies than on natural distribution.
2. **Data Size and Source** – Some regions' data might be incomplete, or collection methods could introduce variations.
3. **Impact of Human Intervention** – In areas with strong social and demographic influences, Benford's Law may not apply perfectly.

4.3 Graphical Presentation

To illustrate the comparison between observed and expected frequencies, a bar chart was constructed where the X-axis represents digits 1 to 9, and the Y-axis indicates frequency counts. Each digit is represented by two bars: one for the observed frequency and one for the expected frequency based on Benford's Law. This graphical representation provides a clear visual comparison of how closely the observed data aligns with the expected natural distribution.



From the bar chart, it is also evident that although some statistical deviations exist, the overall pattern does not indicate any substantial discrepancy. The graph supports the interpretation that there is no strong evidence of manipulation or electoral fraud in the vote count data.

The dataset used for analysis is provided in the appendix for transparency. All calculations and graphical representations were performed using Microsoft Excel and statistical software tools.

5. CONCLUSION

The analysis of Delhi Assembly election results using Benford's Law suggests that the vote count data is largely consistent with natural digit distribution, indicating no major irregularities. The Chi-square goodness-of-fit test revealed statistically significant deviations (p-value < 0.05); however, these deviations do not conclusively imply electoral fraud. Instead, they may be attributed to contextual factors such as political campaign strategies, demographic patterns, or data limitations. Graphical analysis further supports the interpretation that the overall pattern does not suggest deliberate manipulation.

In the broader context of ongoing political and technical criticisms regarding the use of Electronic Voting Machines (EVMs), the application of Benford's Law serves as a neutral and scientific method for assessing electoral integrity. Such statistical tools promote transparency, encourage data literacy, and provide an empirical framework for investigating voting patterns in democratic processes.

Future research should consider:

- Expanding the dataset by including results from multiple elections and historical data.
- Applying more advanced statistical methods such as second-digit Benford analysis, digital root tests, or machine learning-based anomaly detection.
- Conducting comparative studies across different regions or countries to enhance the scope of election forensics and refine data validation tools.

ISSN: 3107-6513

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7. Appendix

Dataset Used for Benford's Law Analysis:
The dataset includes vote counts of 880 candidates across 70 constituencies in the 2020 Delhi Assembly Elections. The data was retrieved from the official records of the Election Commission of India (https://eci.gov.in).