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Benford's Law to detect anomalies in regional government expenditure during Indonesia's 2024 simultaneous regional elections

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ABSTRACT

During Indonesia's simultaneous regional elections (Pilkada), concerns arise regarding the potential misuse of regional budgets by incumbent regional heads for electoral gain. This study applies Benford's Law to screen for potential anomalies in regional government expenditure during the 2024 elections. The analysis covers personnel, capital, grant, and social assistance expenditures reported in the 2022–2024 audited budget realization reports of 269 regions with incumbent candidates, selected through purposive sampling. Using a quantitative approach, the study examines first-digit, second-digit, and first-two-digit distributions through Z-tests, chi-square tests, and mean absolute deviation (MAD) measures. The findings reveal different deviation patterns across expenditure categories and digit tests. In the first-digit test, personnel and capital expenditures consistently deviate from Benford's Law across all three years, while grant and social assistance expenditures exhibit varying results. In the second-digit test, deviations are more limited, with significant digit-level deviations identified in selected categories and years. The first-two-digit test identifies significant digit combinations across all expenditure categories and years, although chi-square results indicate overall distributional deviations only in selected cases. These findings demonstrate the usefulness of Benford's Law as a preliminary screening tool to identify expenditure data warranting further audit examination, rather than as direct evidence of financial manipulation or electoral misconduct.

KEYWORDS:

Regional Elections, Benford's Law, regional expenditure anomalies, incumbent candidates

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INTRODUCTION

Indonesia's direct regional head elections (Pilkada), implemented since 2005, represent an important milestone in the country's decentralization policy. However, the management of Regional Budgets (Anggaran Pendapatan dan Belanja Daerah) during election periods raises concerns regarding the potential use of public expenditure for electoral purposes. Incumbent regional heads seeking re-election may have incentives to direct discretionary spending toward activities that generate political benefits. Examining regional expenditure during election periods is therefore essential to strengthen public financial accountability and support oversight of local government spending.

Previous studies have investigated regional expenditure patterns within the context of electoral incentives. Sjahrir et al. (2013) identified political budget cycles in Indonesian districts, particularly surrounding direct elections and incumbent reelection. Habibi and Suswanta (2019) examined grant and social assistance expenditure in relation to electoral dynamics, while Setiawan and Setyorini (2018) and Tanjung and Alamsyah (2023) investigated expenditure patterns surrounding electoral periods. Auliyah et al. (2020) also examined several expenditure categories in relation to incumbent reelection during the 2017 regional elections. Collectively, these studies demonstrate the relevance of examining local government spending in the context of electoral competition. Nevertheless, changes in expenditure levels or composition do not, by themselves, establish that public funds have been manipulated for electoral gain.

Concerns regarding regional expenditure accountability also extend to the potential misuse of public resources in social assistance, personnel expenditure, and infrastructure development. Previous research has examined changes in grant, social assistance, and capital expenditure around election periods (Amalia & Pratolo, 2013; Ritonga & Alam, 2010; Setiawan & Setyorini, 2018). Other research has addressed risks of irregularities in public expenditure and infrastructure projects. For example, Kombong et al. (2021) examined irregularities in Indonesian construction projects associated with corruption cases. Although such research highlights the importance of expenditure oversight, it does not necessarily establish a direct relationship between irregularities and electoral incentives. These findings underscore the need for complementary analytical approaches that flag expenditure data warranting further scrutiny without presuming that unusual patterns constitute definitive evidence of misconduct.

Benford's Law provides one potential approach for examining numerical anomalies in financial data. It describes the expected frequency distribution of leading digits in many naturally occurring numerical datasets and has been applied in accounting and auditing to identify unusual numerical patterns. Da Silva (2025) examined the application of Benford's Law in auditing datasets, while Nigrini (2017) reviewed its use in audit sampling and accounting research. Druică et al. (2018) also discussed the analytical potential and limitations of digit analysis. These studies indicate that deviations from expected digit distributions can serve as preliminary signals for further examination. However, such deviations do not, by themselves, establish fraud or financial manipulation. The suitability of Benford's Law depends on the characteristics of the data, including their numerical distribution and range of magnitudes.

In Indonesia, previous applications of Benford's Law have examined corporate financial statements and other financial datasets. Bwarleling (2020) analyzed financial statements involving PT Garuda Indonesia; Fangohoi and Lesmana (2023) examined financial records associated with PT Jiwasraya; Murhaban and Jufrizal (2017) investigated customs transaction data; and Sihombing and Valira (2024) analyzed financial sector companies listed on the Indonesia Stock Exchange.

International research has likewise considered Benford's Law as a tool for identifying irregularities in numerical datasets (Li et al., 2019). While these studies demonstrate the use of digit-distribution analysis across various financial contexts, its application to local government expenditure during regional elections remains underexplored in the existing literature.

The 2024 simultaneous regional elections provide a relevant context for examining regional government expenditure in jurisdictions where incumbent regional heads sought reelection. Agency Theory conceptualizes the public as the principal and regional heads as agents entrusted with managing public resources. Information asymmetry and managerial discretion may create opportunities for decisions that do not fully align with public interests. Political Budget Cycle Theory complements this perspective by explaining how electoral incentives may influence government spending decisions around election periods. Together, these theories provide a conceptual basis for examining expenditure patterns in regions with incumbent candidates. However, neither the presence of an incumbent candidate nor a deviation from Benford's Law establishes that expenditures were manipulated for electoral purposes.

Previous studies have demonstrated the applicability of Benford's Law in examining the reliability of government-related and public sector financial data. Rauch et al. (2011), for example, applied Benford's Law to assess the reliability of macroeconomic data reported by European Union member states. Similarly, Arslan et al. (2024) combined Benford's Law with the Beneish Model to examine financial statement anomalies in a public sector hospital. These studies illustrate the potential of digit analysis as an analytical approach for identifying unusual patterns in public sector financial information. However, its application to regional government expenditure in electoral contexts remains an area warranting further investigation.

The research gap lies in the distinction between examining changes in expenditure amounts or composition and assessing whether expenditure figures conform to expected numerical distributions. Research on political budget cycles has generally focused on changes in expenditure patterns during electoral periods. Although previous studies have applied Benford's Law to various financial datasets, including government-related and public sector financial information, its application to regional government expenditure during electoral periods remains relatively limited. This study brings these two areas together by applying Benford's Law to regional government expenditure realization data in jurisdictions where incumbent regional heads participated in the 2024 simultaneous regional elections. Its empirical contribution extends digit distribution analysis to local government finance in an electoral context, while its practical contribution assesses the method's potential usefulness as an initial screening procedure for auditors and public financial oversight institutions.

Previous studies applying Benford's Law to financial data have reported deviations between observed digit distributions and those expected under the law. Bwarleling (2011), Fangohoi and Lesmana (2023), and Sihombing and Valira (2024) examined digit distributions in corporate financial records and identified deviations warranting further examination. These findings provide a basis for testing whether similar deviations occur in regional government expenditure data. Accordingly, the first hypothesis is formulated as follows:

H1: The observed first-digit frequency distribution of grant, social assistance, personnel, and capital expenditure differs significantly from the distribution expected under Benford's Law.

In addition to the leading digit, the second-digit distribution provides another perspective for assessing conformity with Benford's Law. Previous studies have applied digit analysis to financial datasets and reported deviations from expected distributions. Research by Bwarleling (2020),

Sihombing and Valira (2024), and Fangohoi and Lesmana (2023) illustrates the use of digit-distribution analysis to examine financial records for unusual numerical patterns. The second-digit test complements the first-digit test because it examines a different position in the numerical values and may reveal deviations that are not apparent from the leading digit alone. Based on this rationale, the second hypothesis is formulated as follows:

H2: The observed second-digit frequency distribution of grant, social assistance, personnel, and capital expenditures differ significantly from the distributions expected under Benford's Law.

The first-two-digit test extends digit analysis by examining combinations ranging from 10 to 99. Unlike tests that consider a single digit position, this test evaluates the distribution of two-digit combinations and provides a more detailed assessment of numerical conformity. Previous studies, including Bwarleling (2020), Fangohoi and Lesmana (2023), Sihombing and Valira (2024), and Murhaban and Jufrizal (2017), have applied digit-distribution analysis to financial or transaction datasets. Their work provides a basis for examining whether numerical observations conform to expected digit patterns. In the context of regional government expenditure, the first-two-digit test offers an additional means of identifying deviations that may warrant further investigation. Therefore, the third hypothesis is formulated as follows:

H3: The observed first-two-digit frequency distributions of grant, social assistance, personnel, and capital expenditures differ significantly from the distributions expected under Benford's Law.

In light of these hypotheses, this study examines expenditure realization data for 2022–2024 from 269 regions in which incumbent regional heads participated as candidates in the 2024 simultaneous regional elections. Specifically, the analysis evaluates grant, social assistance, personnel, and capital expenditures using first-digit, second-digit, and first-two-digit tests to assess conformity with Benford's Law. The findings are intended to provide preliminary analytical insights for the Audit Board of the Republic of Indonesia (BPK RI), the Financial and Development Supervisory Agency (BPKP), and local government inspectorates in identifying expenditure data that merit further examination. The study identifies potential numerical anomalies rather than directly establishing fraud, manipulation, or electoral misconduct.

RESEARCH METHOD

Research Design and Data

This study employs a quantitative approach to examine numerical patterns in regional government expenditure realization reports using Benford's Law. The analysis focuses on four expenditure categories: personnel expenditure, grant expenditure, social assistance expenditure, and capital expenditure. The data cover the 2022–2024 fiscal years and were obtained from audited Budget Realization Reports (Laporan Realisasi Anggaran/LRA) available on official local government websites.

The study population consisted of 525 regions. Of these, 312 participated in the 2024 simultaneous regional elections. The final sample comprised 269 regions with incumbent regional heads seeking reelection that met the predetermined sampling criteria. The sample selection employed purposive sampling based on the following criteria: (1) the presence of an incumbent regional head seeking reelection in the 2024 simultaneous regional elections; (2) the availability of

audited LRA data for the 2022–2024 period that could be accessed online through the respective local government websites; and (3) the inclusion of grant expenditure, social assistance expenditure, personnel expenditure, and capital expenditure data in the LRA. The selection resulted in 807 region-year observations (269 regions × 3 years).

The unit of observation in the Benford's Law analysis is the monetary value recorded at the detailed expenditure account level in the LRA. Accordingly, the dataset consists of expenditure amounts classified by expenditure category and fiscal year, rather than individual financial transactions or aggregate expenditure totals. Each eligible expenditure amount constitutes one numerical observation for digit analysis. The number of numerical observations used in each expenditure category and fiscal year is reported in Table 1.

Table 1. Sample Selection

Criteria	Amount
Regions will hold simultaneous regional elections in 2024	525
Incumbents opting not to seek re-election in the 2024 Simultaneous Regional Elections	175
Regions that did not publish financial documents, namely the 2022 budget execution report (LRA)	47
Regions that failed to disseminate financial data, namely the budget realization report (LRA) for the years 2023 and 2024	34
Total Areas that meet the criteria	269
Observation Year 2022 – 2024	269 X 3 Years
Total Sample	807

Application of Benford's Law

Benford's Law describes the expected distribution of leading digits in naturally occurring numerical datasets. Under this law, smaller leading digits occur more frequently than larger ones. Its application is generally appropriate for datasets containing sufficient variation across multiple orders of magnitude and is less suitable for data consisting of predetermined, restricted, or uniformly distributed values.

In this study, Benford's Law is applied to examine the distribution of digits in the four regional expenditure categories. Three digit tests are employed: the first-digit test, the second-digit test, and the first-two-digit test. The expected probability for each digit or digit combination is calculated using the following formulas.

The First-Digit Test

The First Digit Test seeks to examine the frequency of the initial digit in the data of the Regional Budget realization report. The theoretical probability of each initial digit d (ranging from 1 to 9) is determined using the subsequent formula:

$$P(d) = log\left(1 + \frac{1}{d}\right) \qquad \text{..... (1)}$$

The Second-Digit Test

The Second Digit Test evaluates the distribution of the second digit in report numbers. The distribution of the second digit is more uniform than that of the first digit; yet, it still follows a certain pattern. The theoretical probability of the second digit d (ranging from 0 to 9) is determined using the formula:

$$P_2(d) = \sum_{k=1}^{9} \log(1 + \frac{1}{10k+d}) \quad \text{..... (2)}$$

This process involves all possible combinations of the first digit *k* with the second digit *d*.

The First-Two-Digit Test

The First-Two-Digit Test amalgamates the initial and secondary digits to assess the distribution of the first two digits. The theoretical probability of a combination of the first two digits (ranging from 10 to 99) is determined using the following formula:

$$P_{12}(ab) = log\ (1 + \frac{1}{ab}) \quad \text{..... (3)}$$

After the digit distribution is calculated based on actual and theoretical data, the next step is to measure the agreement between the two distributions.

Statistical Tests

The conformity between the observed and expected digit distributions is evaluated using the Chi-Square test, the Z-test, and the Mean Absolute Deviation (MAD). These measures provide complementary information on the extent and statistical significance of deviations from the expected Benford distribution. The formula for the Chi-Square test is as follows:

$$x^2 = \sum \frac{(O_i - E_i)^2}{E_i} \quad \text{..... (4)}$$

where (O_i) denotes the observed frequency for digit category (i), (E_i) denotes its expected frequency under Benford's Law, and (k) represents the number of digit categories tested. A statistically significant result indicates that the observed distribution differs from the expected distribution.

The Z-Test is used to test the significance of the deviation of the mean of the actual distribution from the theoretical distribution. The following is the formula for the Z-Test:

$$Z = \frac{\bar{X} - \mu}{\frac{\sigma}{\sqrt{n}}} \quad \text{..... (5)}$$

$\bar{X}$ represents the mean of the real distribution, while μ denotes the mean of the theoretical distribution, μ is the mean of the theoretical distribution, σ is the population standard deviation, and n is the sample size. A significant Z-Test result indicates a significant deviation from the mean, indicating a mismatch in the data distribution.

MAD is a statistical technique employed to quantify the mean absolute deviation between real and theoretical distributions. A MAD value greater than a certain threshold (e.g., 0.015 for the First Digit Test) is considered an indication of data anomalies. The MAD formula is:

$$MAD = \frac{\sum |O_i - E_i|}{n} \quad \text{..... (6)}$$

The analysis process in this study relies on a digital-based approach using Python-based software. The fundamental purpose of this approach is to automate financial data analysis based on Benford's Law, enhancing the accuracy and efficiency of detecting financial irregularities in regional

budget (APBD) realization reports. The following steps will be implemented to support the digital analysis process:

Data Processing and Analysis

The data were processed and analyzed using Python. The numerical expenditure amounts obtained from the LRA were prepared for digit analysis by converting the data into a numerical format and excluding blank or invalid values. The observed frequencies and proportions were then calculated for each digit category and expenditure type for each fiscal year. The observed distributions were compared with the expected distributions under Benford's Law using the three digit tests. The Chi-Square test, Z-test, and MAD were subsequently calculated to evaluate the extent and significance of deviations. The results were presented in tables and graphical comparisons of observed and expected digit distributions to facilitate interpretation.

Deviations from Benford's Law are treated as indicators of numerical anomalies rather than direct evidence of fraud, manipulation, or budget misuse. Such deviations may also arise from the structural characteristics of the expenditure data. Therefore, the findings should be interpreted as preliminary signals that may warrant further examination, rather than as conclusive evidence of irregularities. Visualization is a crucial component of the analytical process, facilitating intuitive comprehension of the results. The application will produce a bar graph that contrasts the actual digit distribution with the theoretical distribution derived from Benford's Law. These visualizations are intended to help identify patterns of significant deviation. Visualization libraries, such as Matplotlib or Seaborn, are used to generate clear and informative graphical representations.

RESULT AND DISCUSSION

Sample Characteristics and Overview of the Analysis

The study examined expenditure realization data from 269 regional governments with incumbent candidates participating in the 2024 simultaneous regional elections. The sample was selected from 525 regions in the study population, of which 312 participated in the 2024 regional elections. The analysis covered four expenditure categories: personnel expenditure, grant expenditure, social assistance expenditure, and capital expenditure; over 2022–2024, resulting in 807 region-year observations.

Benford's Law was applied through three digit tests: the first-digit test, the second-digit test, and the first-two-digit test. The Z-test was used to identify statistically significant deviations in individual digit frequencies or digit combinations, while the Chi-Square test assessed the conformity of the overall observed distribution with the expected Benford distribution. MAD was used to measure the magnitude of the average deviation between observed and expected proportions. The detailed results are presented in Appendix Tables A.1–A.3.

First-Digit Analysis: Comparison with Benford's Law

The results of the first-digit analysis are presented in Table A.1. The findings indicate that deviations from Benford's Law vary across expenditure categories and fiscal years. Personnel expenditure and capital expenditure exhibit relatively consistent deviations throughout the 2022–2024 period. For both categories, the Z-test identifies significant deviations in specific first digits, while the Chi-square test indicates that their overall distributions do not conform to Benford's Law. Their MAD classifications are also reported as "No match" or "No fit".

In contrast, grant expenditure shows no significant deviation in 2022 and 2023, as indicated by the Z-test, Chi-square test, and MAD classifications. However, deviations are identified in 2024, when the Z-test identifies significant deviations in digits 4 and 5, the Chi-square test indicates a failure to conform, and the MAD classification is "No match." Social assistance expenditure presents a less consistent pattern. In 2022, the Z-test and Chi-square test indicate deviations, accompanied by a "No match" MAD classification. No significant deviations are identified in 2023. In 2024, although the Z-test identifies a significant deviation in digit 4, the Chi-square test indicates that the overall distribution passes the goodness-of-fit assessment, and the MAD classification is "Acceptable."

These findings suggest that the conformity of first-digit distributions differs across expenditure categories and fiscal years. The relatively consistent deviations in personnel and capital expenditure contrast with the more year-specific patterns observed in grant and social assistance expenditure. Nevertheless, the presence of a significant deviation in an individual digit should be distinguished from the overall conformity of the distribution, as illustrated by the 2024 social assistance expenditure results.

The findings can be discussed in relation to previous studies applying Benford's Law to financial statements and accounting data. Bwarleling (2020), PT Garuda (2020), Sihombing and Valira (2024), and Fangohoi and Lesmana (2023) are cited in the original study as reporting differences between observed first-digit frequencies and the distributions expected under Benford's Law. Although these studies examine different financial contexts, their application of digit-distribution analysis provides a relevant point of comparison for the present study. The current findings extend this line of inquiry to regional government expenditure accounts, showing that deviations from expected first-digit distributions may also occur in public-sector financial data. Such deviations, however, should be interpreted as preliminary indicators of unusual numerical patterns rather than direct evidence of irregularities or fraud.

Second-Digit Analysis: Comparison with Benford's Law

The second-digit test provides an additional layer of assessment by examining the distribution of the second digit in expenditure amounts. The results are presented in Appendix Table A.2. In 2022, none of the four expenditure categories exhibits significant deviations according to the Z-test. The Chi-square results also indicate that all four distributions conform to Benford's Law, with MAD classifications ranging from "Good match" to "Close match." In 2023, the Z-test identifies significant deviations in personnel expenditure (digits 8 and 9), capital expenditure (digit 8), and grant expenditure (digit 1). However, the Chi-square test indicates an overall deviation only for grant expenditure, while personnel and capital expenditure still pass the goodness-of-fit assessment. Social assistance expenditure shows no significant deviation in that year. In 2024, the Z-test identifies a significant deviation only in social assistance expenditure (digit 0), which is also accompanied by a failure in the Chi-square test. The other three expenditure categories show no significant deviations and pass the Chi-square assessment.

The results demonstrate that significant deviations in individual second digits do not necessarily indicate that the entire distribution departs from Benford's Law. This distinction is particularly evident in personnel and capital expenditure in 2023, where the Z-test identifies specific deviations but the Chi-square test indicates overall conformity. Conversely, grant expenditure in 2023 and social assistance expenditure in 2024 show deviations in both individual digits and their overall distributions. The MAD classifications, which remain within the "Acceptable" or "Close match" categories, provide an additional measure of the average magnitude of deviations.

These findings can be considered alongside previous applications of Benford's Law to financial data. Bwarleling (2020), PT Garuda (2020), and Sihombing & Valira (2024), as cited in the original manuscript, reported differences between observed second-digit distributions in financial records and those expected under Benford's Law. Nigrini (2017) and Fairweather (2017) are also cited in relation to the application of digit-distribution analysis to financial and tax data. These studies provide a basis for understanding the use of second-digit analysis as a complementary screening procedure. In the present study, the second-digit test identifies deviations that are not always apparent from the first-digit analysis, indicating that examining different digit positions may provide additional information about the numerical patterns of expenditure data.

First-Two Digit Analysis

The first-two-digit test extends the analysis by examining the frequency distribution of digit combinations ranging from 10 to 99. The results are presented in Table A.3. The Z-test identifies significant deviations in specific two-digit combinations across all four expenditure categories and all three fiscal years. Personnel expenditure exhibits significant combinations in each year, while capital, grant, and social assistance expenditure also show deviations, although the number and combinations of significant digits vary across years.

The Chi-square results, however, indicate that not all of these distributions depart from Benford's Law as a whole. The test indicates deviations in personnel expenditure in all three years and in capital expenditure in both 2022 and 2023. Grant and social assistance expenditure pass the Chi-square assessment in all three years, while capital expenditure also passes in 2024. Furthermore, all MAD classifications in Table A.3 are reported as "Close match," "Close fit," or "Acceptable."

This finding is consistent with Bwarleling (2011), who explains that the first-two-digit test can help identify numerical anomalies that may not be detected through the first-digit test alone. In the context of audit planning, this test provides an additional analytical procedure for identifying accounts that warrant further examination. Accordingly, the application of multiple digit tests in this study provides complementary perspectives for screening regional expenditure data and identifying specific numerical patterns that may require further audit attention.

These results highlight the distinction between significant deviations in particular two-digit combinations and the conformity of the overall distribution. Although the Z-test identifies specific combinations that differ significantly from Benford's Law, the Chi-square and MAD results indicate that several expenditure distributions remain relatively close to the expected pattern when assessed as a whole. Accordingly, the presence of significant two-digit combinations should not automatically be interpreted as evidence that the entire expenditure distribution is anomalous.

The first-two-digit analysis provides a more granular examination of numerical patterns than tests based on a single digit position because it considers 90 possible combinations. Previous studies cited in the original manuscript, including Bwarleling (2020), PT Garuda (2020), Sihombing and Valira (2024), and Fangohoi and Lesmana (2023), have applied digit-distribution analysis to financial data. Nigrini (2012), Murhaban (2017), and Arkan (2020) are also cited in relation to deviations in financial and taxation data. These studies provide a relevant methodological background for examining numerical conformity using Benford's Law. In the context of this study, the first-two-digit test adds detail by identifying particular combinations that may warrant further examination. However, the results do not establish that this test is inherently more accurate or that it identifies irregularities at the individual transaction level, since the observations in this study are expenditure-account amounts reported in the LRA.

Cross-Test Discussion and Implications

Taken together, the three tests reveal that deviations from Benford's Law are not uniformly distributed across expenditure categories, digit positions, or fiscal years. The first-digit analysis identifies relatively consistent deviations in personnel and capital expenditure throughout 2022–2024, whereas grant and social assistance expenditure exhibit more year-specific patterns. The second-digit analysis generally indicates greater conformity, with deviations concentrated in selected categories and years. Meanwhile, the first-two-digit analysis identifies significant deviations in specific digit combinations across all expenditure categories and years, although the overall distributions assessed by the Chi-square test and MAD do not uniformly indicate nonconformity.

The differences among the three tests reflect their distinct analytical functions. The Z-test identifies specific digits or digit combinations with statistically significant deviations from expected proportions. The Chi-square test evaluates the conformity of the overall observed distribution, while MAD measures the average magnitude of deviation. Consequently, their results should be interpreted together rather than treating one test as conclusive. In particular, significant Z-test results do not necessarily imply that the overall distribution fails the goodness-of-fit assessment. The findings also suggest that examining multiple digit positions can provide complementary information when screening financial data for unusual numerical patterns.

The practical use of Benford's Law as a preliminary analytical procedure is also discussed by Bwarleling (2017), who highlights its potential to support audit planning and the identification of accounts requiring further examination. However, the applicability of this approach depends on the characteristics of the data being analyzed. This reinforces the need to interpret deviations from expected digit distributions as preliminary indicators rather than conclusive evidence of fraud or financial irregularities. Similarly, Arslan et al. (2024) applied Benford's Law alongside the Beneish Model to examine financial statement anomalies in a public sector hospital. Their study demonstrates how digit analysis can complement other analytical techniques in assessing the reliability of public sector financial information. This further supports applying Benford's Law to screen regional government expenditure data for items warranting further audit examination.

From an audit perspective, deviations identified through Benford's Law may serve as preliminary screening signals for prioritizing expenditure accounts that merit further examination. Auditors may use these results to direct subsequent procedures, such as examining supporting documentation, assessing the underlying transactions, and evaluating relevant internal controls. Nevertheless, Benford's Law is not a standalone fraud detection method. A deviation from the expected digit distribution does not, by itself, establish fraud, manipulation, misuse of public funds, or electoral misconduct.

The relevance of examining financial data during electoral periods is also supported by Capalbo et al. (2023), who applied Benford's Law to the financial statements of municipally owned entities and identified deviations during pre-election periods. Their findings suggest that electoral contexts may warrant closer attention to the quality of financial reporting. However, deviations from Benford's Law do not automatically indicate illegal manipulation or fraud. Although the present study examines regional government expenditure in a different institutional and national context, both studies highlight the potential of digit analysis as a preliminary screening approach for identifying financial data that merit further examination. Nevertheless, the findings of the present study do not establish a causal relationship between incumbent participation in elections and the observed expenditure anomalies.

The findings provide a screening perspective on the conformity of regional government expenditure data with Benford's Law in regions where incumbent regional heads participated in the 2024 simultaneous regional elections. Although the analysis covers both pre-election years (2022 and 2023) and the election year (2024), it does not establish that the observed deviations were caused by electoral incentives or that differences between years are statistically significant. Rather, the results identify numerical patterns that may inform further audit examination and provide a basis for more detailed investigation of regional expenditure management.

This study has several limitations. First, the analysis is limited to 269 regional governments in which incumbent regional heads participated in the 2024 simultaneous regional elections, covering the 2022–2024 fiscal years. Therefore, the findings may not be generalizable to all regional governments in Indonesia. The study also focuses on four expenditure categories: personnel expenditure, capital expenditure, grant expenditure, and social assistance expenditure. Other categories, such as goods and services expenditure, are not included. In addition, the observations consist of detailed expenditure-account amounts reported in the Regional Budget Realization Reports (LRA), rather than individual financial transactions.

Second, Benford's Law is a preliminary screening tool and cannot independently establish the occurrence of fraud or budget misuse. Deviations from expected digit distributions may arise from the inherent characteristics or structure of financial data rather than fraudulent activities. Furthermore, this study does not include a comparison group of regions without incumbent candidates or a specific statistical test comparing pre-election and election years. Consequently, the observed deviations cannot be directly attributed to electoral participation or political incentives. Further examination using supporting documentation, transaction records, and other audit procedures is necessary to establish whether the identified deviations indicate actual irregularities.

CONCLUSION

This study applies Benford's Law to examine the digit distributions of regional government expenditure realization data for 2022–2024 from 269 regions in which incumbent regional heads participated in the 2024 simultaneous regional elections. The analysis covers four expenditure categories: personnel expenditure, capital expenditure, grant expenditure, and social assistance expenditure. The findings reveal deviations from Benford's Law across these categories, although their patterns vary by expenditure category, fiscal year, and digit position. Personnel and capital expenditure exhibit relatively consistent deviations in the first-digit analysis, whereas grant and social assistance expenditure show more year-specific patterns. The second-digit and first-two-digit analyses provide additional insights into specific digit deviations that are not necessarily reflected in the overall distributional conformity. These findings demonstrate the value of examining multiple digit positions when assessing numerical patterns in regional expenditure data. However, the identified deviations should be interpreted as preliminary screening signals rather than direct evidence of fraud, budget manipulation, or misuse of public funds.

From the perspective of public financial accountability, Benford's Law can complement existing oversight and audit procedures by helping identify expenditure accounts with unusual numerical patterns that warrant further examination. BPK, BPKP, and regional inspectorates may use this approach as an initial analytical procedure to support risk identification and prioritize subsequent audit work. Nevertheless, its application should consider the characteristics of the underlying financial data and be complemented by other audit procedures, including examination of supporting documentation, transaction records, and internal controls. Conclusions regarding

potential irregularities must ultimately be based on sufficient and appropriate audit evidence.

Future research may extend the analysis by including additional regional expenditure categories, particularly goods and services expenditure, as well as expenditure data from BLU/BLUD entities. The scope of the dataset may also be expanded to include a broader range of regional governments and longer observation periods, subject to the suitability and availability of the underlying data for Benford's Law analysis. Further studies could examine additional digit positions, such as the third and fourth digits, and apply complementary analytical approaches to strengthen the assessment of numerical deviations. Moreover, future research could incorporate comparative designs involving regions with and without incumbent candidates to investigate whether expenditure digit patterns differ across electoral contexts. For practical application, regional inspectorates at provincial, regency, and municipal levels may consider integrating Benford's Law into their preliminary risk-screening procedures for regional budget management. Such application should be undertaken as part of a broader risk-based oversight framework rather than as a standalone method for identifying fraud.

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APPENDICES

Table A.1. First-Digit Test Results

Fiscal Year	Expenditure Category	Significant Digit(s)	Chi-square Test	MAD Classification
2022	Employee Expenditures	Significant anomalies in the numbers: 3, 4, 7	Fail	No match
	Capital Expenditures	Significant anomalies in digits: 1, 2.	Fail	No fit
	Grant Expenditures	No significant frequency anomalies.	Pass	Acceptable
	Social Assistance Expenditures	Significant anomaly in digit: 3	Fail	No match
2023	Employee Expenditures	Significant anomaly in digits: 3, 4, 7.	Fail	No fit
	Capital Expenditures	Anomaly at digits: 1, 2	Fail	No Fit
	Grant Expenditures	No significant frequency anomalies.	Pass	Close Match
	Social Assistance Expenditures	No significant frequency anomalies.	Pass	Close fit
2024	Employee Expenditures	Significant anomalies in the numbers: 4, 5, 6	Fail	No match
	Capital Expenditures	Significant anomalies in digits: 1, 2.	Fail	No fit
	Grant Expenditures	Significant anomalies in digits: 4, 5.	Fail	No match
	Social Assistance Expenditures	Significant anomaly in digits: 4	Pass	Acceptable

Table A.2. Second Digit Test

Fiscal Year	Expenditure Category	Significant Digit(s)	Chi-square Test	MAD Classification
2022	Employee Expenditures	No significant frequency anomalies	Pass	Good match
	Capital Expenditures	No significant frequency anomalies	Pass	Acceptable
	Grant Expenditures	No significant frequency anomalies	Pass	Close Match
	Social Assistance Expenditures	No significant frequency anomalies	Pass	Close Match
2023	Employee Expenditures	Significant anomaly in digits: 8,9	Pass	Acceptable
	Capital Expenditures	Significant anomaly in digits: 8	Pass	Acceptable
	Grant Expenditures	Significant anomalies in digits: 1	Fail	Acceptable
	Social Assistance Expenditures	No significant frequency anomalies	Pass	Close Match
2024	Employee Expenditures	No significant frequency anomalies	Pass	Close match
	Capital Expenditures	No significant frequency anomalies	Pass	Acceptable
	Grant Expenditures	No significant frequency anomalies	Pass	Close match
	Social Assistance Expenditures	Significant anomaly in digits: 0	Fail	Acceptable

Table A.3. First-Two-Digit Test

Fiscal Year	Expenditure Category	Significant Digit(s)	Chi-square Test	MAD Classification
2022	Employee Expenditures	Significant anomalies in the numbers: 35, 37, 39, 42, 46, 54, 65, 72, 82, 97	Fail	Close match
	Capital Expenditures	Significant anomalies in digits: 13, 15, 19, 24, 26, 34, 99	Fail	Close Fit
	Grant Expenditures	Significant anomalies in the numbers: 40, 50, 70, 80, 85	Pass	Close Match
	Social Assistance Expenditures	Significant anomalies in digits: 31, 38, 47, 64, 89	Pass	Close Match
2023	Employee Expenditures	Significant anomaly in digits: 26, 30, 37, 38, 39, 40, 41, 44, 48, 49, 58, 72, 75, 77, 78.	Fail	Close Fit
	Capital Expenditures	Significant anomalies at digits: 15, 16, 18, 22, 25, 36, 88, 98	Faio	Acceptable
	Grant Expenditures	Significant anomalies in digits: 10, 22, 54, 71, 78.	Pass	Close Match
	Social Assistance Expenditures	Significant anomalies in digits: 49, 50, 73, 93, 99	Pass	Close Fit
2024	Employee Expenditures	Significant anomalies in the numbers: 40, 49, 50, 52, 55, 66, 68, 69, 97, 99	Fail	Close match
	Capital Expenditures	Significant anomalies in digits: 16, 21	Pass	Close fit
	Grant Expenditures	Significant anomalies in digits: 36, 43, 44, 45, 51, 55, 57, 58, 64	Pass	Close match
	Social Assistance Expenditures	Significant anomaly in digits: 10, 38, 40, 43, 80, 90	Pass	Close Fit

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Author Contribution

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Competing interest

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The use of AI or AI-assisted technologies

During the preparation of this work, the authors used ChatGPT (OpenAI) to assist in translating excerpts of the source documents into English, identifying potential issues in the manuscript, improving the clarity and coherence of the writing, and checking and formatting references. Grammarly was used for English-language proofreading and grammatical correction. All AI-assisted translations were verified against the original texts, and all references were checked against their original sources. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.