

DIGITAL AUDIT ANALYTICS: APPLYING BENFORD'S LAW TO MITIGATE RISK AND DETECT MATERIAL MISSTATEMENT IN FINANCIAL STATEMENTS: A CASE STUDY OF LUCKY CEMENT FACTORY

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Abstract

The main purpose of this study is to use Benford's Law as a tool for fraud detection and prevention in different corporate organizations in Pakistan. This law is based on the principle of relative frequency distribution of the leading digits of the numbers in datasets, which would help in ensuring conformity to this law. The data used were historical data of the quoted company DG Khan Cement Company Limited (DGKC) with an observed frequency count of 1215 digit observations, which demonstrates practically the usefulness of Benford's Law. The respondents for the questionnaires were accountants, auditors, and accounting tutors representing various localities of Karachi. The digit analysis was done using Benford's Law V2.0 software, and the questionnaire responses were analyzed using Two-Way Analysis of Variance. Two hypotheses were generated and tested. The findings showed that Benford's Law was useful in empirical data analysis for fraud detection and that the Law was a statistical tool that can be used in audit analytical procedures. The respondents indicated that statistical techniques were much more satisfactory than intuition-based red flags techniques and financial ratio techniques. This research advocates the addition of more advanced statistical techniques to audit fraud-detection schemes. Such a design of audit analytical procedures could be helpful for auditors in mitigating the risk of fraud and exposing material misstatement inherent in financial statements.

Keywords: *Audit analytical procedures, Risk mitigation, Material misstatement, Financial statement audit, Benford's Law, Fraud detection, Forensic auditing.*

1. Introduction

The perception of fraud has long existed. Cleary and Thibodeau (2005) observed that fraud existed even before the beginning of commercialization. This statement was supported by Shiraz Rahaman (2009), who noted that fraud is as old as goods transfers and considerably older than trade itself. Fraud has been counted as a business, and its value increases every year in numerical and financial terms if somebody continues it. This manipulation is now broadly reported to in the empirical and scholarly literature as Fraudulent Financial Reporting (FFR). The world's economies suffer billions of dollars in fraudulent-financial-reporting costs every year.

The Association of Certified Fraud Examiners (ACFE, 2007) presented financial statement fraud as a conscious falsification of the financial condition of an enterprise, realized by:

- Intentionally misstating amounts;
- Omitting amounts; or
- Disclosing information in the financial statements in a manner intended to deceive users.

Baird and Elliott (2018) described fraud as an intentional act of deception that can be characterized as dishonesty and false representation. From this, it can be inferred that the key difference between fraud and error is intent: errors are unintentional, whereas fraud is deliberate (IFAC, 2006).

The concept of FFR has shifted from a country-based to a global one. Since the 1990s, fraud has emerged as one of the biggest challenges to the world economy, impacting not only large companies and financial institutions, but also small enterprises and individuals, who are indirectly responsible and vulnerable due to the rise in prices of goods and services. This common experience is exemplified by recent corporate scandals such as Enron, Global Crossing and WorldCom, Tyco and Cadbury Plc.

According to Bello y Villarino (2021), there are four types of fraud.

- Mishandling of funds by the company's management (e.g., theft, corruption, and misappropriation);
- Misconduct against the company by management (such as breaking government requirements, tax, securities, etc. laws);

Collective crimes of management, officers, directors, employees, and agents; and
Third party crime (e.g. vendor, contractors and suppliers).

Auditors are often hired to discover losses due to financial statement fraud and management fraud to the company. New developments have opened up new challenges that were not around before (Cooper, Dacin, & Palmer, 2013), such as:

- More transactions because of the complexity of today's business;

- An improvement in information technology (IT) systems; and

The general idea among fraudsters is that this kind of practice is challenging to detect. In recent years, fraud is increasingly difficult to detect and prevent. Despite improved accounting control and regulation, fraudsters will always find ways to circumvent them. The type of fraud is evolving and becoming more complicated, and there is a need for well-trained auditors who are ready to adopt more advanced audit techniques and skills to help detect fraud. Therefore, technological development, and the international industrialization, are necessary to surpass the present detection levels in audit procedures. Due to the high-profile audit failures of Barings Bank (Singapore), Allied Irish Bank (UK), Enron (USA), Société Générale (France) and Riječka Banka (Croatia), a new set of analytical tools and methods were developed by the audit profession in Statement on Auditing Standards No. 99 – Consideration of Fraud in a Financial Statement Audit (AICPA, 2002). This has led to a proliferation of business and information-systems auditing in recent times (Jeppesen, 2019). Analytical procedures performed with effective use of computer applications at the transaction level are a cost-effective way for auditors to partially satisfy their responsibility for detecting fraud and material misstatement. It has resulted in the emergence of new auditing approaches that make use of information and communication technology (ICT), which includes Computer-Assisted Auditing Techniques (CAAT) (Grambling & Schneider, 2018). The primary responsibilities of an auditor are to:

- Express a professional opinion on the financial position of a company as presented in the financial statements prepared by its directors;
- Perform their duties with the care, diligence, and skill reasonably necessary in each particular circumstance; and
- Accept liability for negligence, against which directors may institute legal action.

Failure to detect fraudulent financial reporting can expose auditors to serious legal and regulatory consequences. To reduce the incidence of fraud, auditors commonly rely on red flags to assess transaction risk. Neu, Everett, and Rahaman (2013) have discovered that there are two major flaws in this method: the relationship between red flags and fraud is not perfect, and audits tend to only look at certain red flags, but fraud can come from within or outside a business entity.

With the use of modern technology, investigative accountants are being better equipped to identify the perpetrators of financial fraud and to investigate in-depth analytical questions about financial fraud (Liston-Heyes & Juillet, 2021). The general goal of this study is to find out the extent to which a model of statistical reasoning using Benford's Law can be used by auditors in their analytical procedures to detect and prevent fraud. It is a new and innovative method when compared with traditional audit methods like ratio analysis and trend analysis. The Study will aim to: Design a measure of digit deviation from Benford's Law that signals doubtful or fraudulent accounting transactions;

- Identify an appropriate fraud-detection tool to aid auditors in fraud detection and prevention; and

- Compare the use of statistical methods in fraud detection and prevention with conventional audit techniques.

2. Literature Review

2.1. Fraud Definitions and Taxonomy

Misuse, theft, and misappropriation are frequently used interchangeably with the term fraud, but there are different legal implications. Fraud, in general, is the misuse of an organization's profits or systems, although it may not result in any legal ramifications. Paterson et al (2019) define fraud as an act that takes place inside an organization, by management or in favor of an organization. They can be internal or external, and are usually premeditated and hidden. Typically, they are unlawful or a violation of policy, or a moral wrong, which leads to a financial loss to the company or another party, or to a gain for the unethical miscreant, and are therefore a crime or offence.

The Institute of Internal Auditors' Standard 1210.A2 labels fraud as encircling a range of misdeeds and illegitimate acts categorized by premeditated deception or falsification, which an individual knows to be false or does not believe to be true. Fraud essentially involves the practice of using lying, dishonesty, or causing harm to someone else to gain something for oneself (CIMA, 2009). According to CIMA (2009), there are common types of corporate fraud which are identified as:

- Misappropriation of funds or property; or
- Excessive withdrawal of funds; and
- Conflict of interest;
- Misstatement of the financial accounts;
- Fraudulent vouchers;
- Suspense-account fraud;
- Fraudulent expense claims;
- Impersonation of a police officer or other public official; and
- Bribery and corruption.

There are two types of corporate fraud generally: internal fraud is done by individuals in the company that have access to the internal systems, e.g., management or employee fraud, and external fraud is done by parties outside the company but with access to the company's systems, e.g., vendors, suppliers, and contractors may use billing arrangements to their own advantage or provide substandard goods. Customers can also pretend to cause damage to goods or destroy them to get credits/allowances (Okafor, 2008). One of the most common types of corporate fraud is work-related (also known as occupational) fraud.

According to ACFE (2006), occupational fraud and abuse can be defined as deliberate misuses and misapplications of an employing organization's resources or assets for the enrichment of the perpetrator. This type of fraud can be distinguished as management fraud and non-management (employee) fraud, and is driven by the role of the perpetrator.

2.2 Origins and Development of Benford's Law

Benford's Law-based digital analysis represents a data-mining technique applied in auditing to assess digit patterns within accounting records in order to flag irregularities. According to Koreff, Weisner, and Sutton (2021), data mining more broadly involves uncovering patterns that are statistically sound, not previously known, and useful for taking action. For this to work effectively, the source data needs to be accessible, appropriate, sufficient in quality, and clean, while the underlying analytical question must be clearly framed, too complex for basic query or reporting tools alone, and approached using a suitable data-mining framework (Lavrač et al., 2004). Research on fraud detection through data mining tends to face two recurring critiques: limited access to real-world datasets for testing purposes, and a shortage of rigorously developed and published methods (Phua et al., 2007). As a computer-assisted auditing technique, Benford's Law-based digital analysis allows auditors to examine an entire dataset of transactions at once, helping to surface meaningful anomalies that may signal either unintentional errors or deliberate fraud (Nigrini & Miller, 2006).

The first known study of the probability distribution of digits comes from the 19th century. In 1881, Simon Newcomb, astronomer and mathematician, published a two-page paper titled "Note on the Frequency of Use of the Different Digits in Natural Numbers" in the *American Journal of Mathematics*. He found, by observation, that the very early pages of the library copy of the tables of logarithms were far more worn than the later pages, the former containing numbers beginning with small figures, and the latter, with high figures. He found that scientists and researchers searched the digits starting with "1" more often than the digits starting with "2", the digits starting with "2" more often than the digits starting with "3", and so on. Newcomb found a formula for the probability that the first non-zero digit of a number is any given digit d :

$$P(d) = \log_{10}(1 + 1/d), \quad d = 1, 2, 3, \dots, 9$$

According to this calculation, the likelihood that a number's initial digit is 1 is roughly 30%, but the likelihood that it is 9 is just roughly 4.6%.

Newcomb was unable to offer a theoretical explanation for this phenomenon, according to Neu, Everett, and Rahaman (2013). Frank Benford, a physicist at the General Electric Research Laboratories, independently noticed the same pattern of wear in logarithm tables years later and came to the same conclusion as Newcomb: people look up numbers that start with low digits more frequently than those that start with high digits. Benford examined this theory using a variety of data sources and discovered that it held for all of them.

Neu, Everett, and Rahaman (2013) further studied how frequently the first digit 1 or 9 appeared across different numerical ranges, finding that, on average, about 30.6 percent of numbers in large ranges begin with the digit 1, compared with only 4.7 percent beginning with the digit 9. Benford observed that numbers occurring in nature tend to follow a geometric pattern, which he hypothesized explains why so-called "Benford sets" sets of numbers that closely conform to his law are so common. Sequences of geometric shapes have also been found to correspond well with sets of numbers that follow Benford's Law, which holds that a very large proportion of naturally occurring numerical sets follow a simple,

predictable pattern. Using integral calculus, Benford (1938) derived formulas for the expected digital frequencies of the first, second, and combined digits in lists of numbers:

$$\begin{aligned} \text{Prob.}(D_1 = d) &= P(d \leq D_1 < d + 1) \\ &= \log_{10}(d + 1) - \log_{10}(d) \\ &= \log_{10}(1 + 1/d) \end{aligned}$$

where D_1 denotes the first significant digit of a number. Table 1 presents the expected frequencies for digits 0 through 9 in each of the first four digit positions of a number.

Table 1

Expected Benford Frequencies by Digit Position

Digit	First	Second	Third	Fourth
0	-	0.1297	0.1038	0.1052
1	0.3011	0.1039	0.1044	0.1041
2	0.1760	0.1388	0.1060	0.1021
3	0.1245	0.1143	0.1066	0.1030
4	0.0963	0.1033	0.1042	0.1040
5	0.0792	0.0267	0.0958	0.0959
6	0.0666	0.0334	0.0954	0.0949
7	0.0578	0.0604	0.0970	0.0969
8	0.0512	0.0576	0.0956	0.0969
9	0.0457	0.0750	0.0953	0.0978

The data show a significant imbalance in the distribution of the leading digits: 1 should occur approximately 30.1% of the time while 9 should occur about 4.6% of the time. By comparison, the distribution of second digits is much more even. For two-digit combinations, "10" should appear ~4.14% of the time, while "99" is expected to appear at a much lower rate of ~0.44%. It turned out that Benford's (1938) analysis showed that numerical data are systematic; in other words, smaller digits occur much more frequently than the larger ones, and this is now known as Benford's Law (Stephenson, 2016). In the case of random sampling without bias from various distributions, Nigrini and Mittermaier (1997), as reported by Hill (1996), found that when samples from different distributions are combined, the leading digits of the resulting distribution will tend to follow a logarithmic distribution similar to a Benford distribution. Stephenson (2016) classified types of accounting datasets that tend to align with, or deviate from, this law. Separately, Nigrini and Miller (2006) developed a second-order Benford's Law test designed for auditors seeking to uncover fraud, mistakes, or manipulated figures, showing that this refined test produces relatively few false positives while being effective at flagging rounded numbers, regression-generated data, values derived from the inverse of known distributions, and sequencing errors.

3. Research Methodology

The study aims to establish the following objectives.

- To appreciate how Benford's Law can be applied to detect fraud; and
- To develop an analytical procedure for an audit that reduces the risk of, and identifies, material misstatement in financial statements.

3.2 Research Design

This study is exploratory in nature, relying primarily on secondary data to examine the relationships among the variables of interest. A range of parameters was studied, and information was gathered from multiple sources to address the study's objectives.

3.3 Source of Data

Data for the study were obtained from secondary sources, namely the standalone annual reports and forensic accounting disclosures of the selected company.

3.4 Period of the Study

The study covers the period from 2020 to 2025.

3.5 Research Tools

Percentages, ratios, and Benford's Law were applied using MS Excel to meet the objectives of the study.

3.6 Significance of the Study

- The study provides auditors with a deeper understanding on which to base their professional opinion; and
- The study is beneficial to investors and other stakeholders in making funding decisions.

3.7 Limitations of the Study

- The study relies mainly on secondary data drawn from the annual reports of the selected business, so its reliability and findings are contingent on the accuracy of the data published in those reports; and
- The study is limited to a period of five years.

4. Case Background: DG Khan Cement Company Limited (DGKC)

DG Khan Cement is one of the largest cement manufacturers in Pakistan and forms part of the Nishat Group, one of the country's largest private-sector conglomerates. According to a company notice submitted to the Pakistan Stock Exchange, DG Khan Cement reported a net consolidated profit of Rs. 2.06 billion for the quarter ended March 31, a 6 percent decrease from Rs. 2.2 billion in the corresponding period of the prior fiscal year (PSX). Earnings per share (EPS) declined to Rs. 4.71 from Rs. 5.07 over the same period. Gross margins for the first nine months of fiscal year 2020–2021 remained comparatively stable at 42 percent, down 101 basis points year-on-year. Reflecting a 7 percent decline in export shipments, selling expenses fell by 11 percent quarter-on-quarter to Rs. 223 million, bringing the total for the first nine months of the fiscal year to Rs. 728 million — an increase of 17 percent over the same period in the prior year.

5. Analysis

The theoretical frequencies predicted by Benford's Law were compared with the frequencies observed in DGKC's reported financial figures. Table 2 presents the annual first-digit counts for the five years, together with the resulting actual frequency, the corresponding Benford probability, and the variance between the two. Where observed data are fabricated or materially misstated, the resulting frequencies tend to diverge from the frequencies predicted by the law.

The five-year first-digit frequency distribution shows that digit 4 has a Benford-expected probability of 0.0879 against an observed (actual) frequency of 0.087, figures that are closely aligned. Because the actual frequency does not exceed the expected probability by a material margin for this digit, the distribution signals a comparatively low likelihood of fraud for transactions beginning with the digit 4.

Table 2

First-Digit Frequency Distribution — DGKC, 2020–2025

Digit	2020-21	2021-22	2022-23	2023-24	2024-25	Total	Actual	Prob.	Variance
1	27	43	54	58	54	223	0.4010	0.3011	-0.0148
2	23	34	37	35	42	145	0.1661	0.1760	0.0047
3	22	16	39	21	22	112	0.1119	0.1245	0.0123
4	13	14	8	12	15	58	0.0879	0.0963	0.0108
5	11	7	12	10	14	48	0.0442	0.0792	-0.0128
6	6	10	19	13	12	45	0.0549	0.0666	0.0103
7	8	14	7	5	7	29	0.0530	0.0578	-0.0101
8	5	13	14	16	11	45	0.0542	0.0512	0.0207
9	7	4	10	17	11	44	0.0348	0.0457	0.0066
Total						812	1.0000		

The overall pattern of the variances in Table 2 is rather small and uniform in respect of digits, and with no single digit having an extreme variance from its expected Benford probability. This indicates that the distribution of digits in the numbers reported by DGKC generally matches the distribution to be expected when applying Benford's Law over the period covered, rather than the distribution that might be expected if there was significant manipulation of the numbers by the digit. The digits in each number with higher variances (e.g. digits 5 and 8) may require more analytical follow-up by the auditors.

6. Conclusion

According to the results of this study, using Benford's Law as an analytical tool is a very helpful tool for auditors to detect material misstatements in financial statements and fraud. This comparison will help the auditors identify the unexpected distribution pattern of digits that can be investigated in a short time based on the available financial data. The findings suggest that using Benford's Law as an audit analytical tool enhances audit quality, improves audit risk assessment, and provides a more objective and data-driven audit tool than depending solely on traditional audit analytical tools like ratio analysis and red flags. Benford's Law is not a definitive test of fraud, but serves as a valuable screening tool to make auditing more effective and increase transparency, reliability, and confidence in financial reporting. This could be expanded in future research to other industries, using more extensive data sets, and other more sophisticated data-analytics techniques to further enhance fraud-detection efforts.

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