Economic Sciences
https://economic-sciences.com
ES (2025) 21(5S), 56-65| ISSN:1505-4683

From anomalies to insights: leveraging data analytics for Detecting Complex financial frauds

Mukund purohit[1], Dr. Haresh Barot[2]

[1,2]School of Management Studies, National Forensic Sciences University, Sector 9, Near Police Bhavan, Gandhinagar, Gujarat, India

Abstract:

Fraudsters are becoming more sophisticated as they commit frauds at higher rates. Investigators use sophisticated data analytics to identify and define fraud through their investigations to detect fraud. Advanced Data Analytics methods identifies red flags in fraud schemes that could be missed by traditional fraud detection methods. The advanced data analytics methods allowed investigators to review the fraudulent activity that was potentially overlooked by using traditional methods. The two Quantitative Models Were Utilized to Identify Manipulation In the Financial Information of Sun Pharma Ltd were the Piotroski F-Score Model - A Nine-Point Profit/Leverage "Health Check" For Companies and the Altman Z-Score Model - An Established Model for Predicting Bankruptcy.

The analysis of Sun Pharma Ltd. uses both above models to provide an overall understanding of the factors that contribute to the success of a company and how each model contributes to the success of Sun Pharma Ltd. Through the application of these models, it has been demonstrated that Sun Pharma Ltd. is a very financially healthy company.

Keywords: *Fraud detection, financial anomalies, red flags, Data Analytics*

Introduction:

Fraud is defined as the use of deceit or misrepresentation to one's advantage, either financially or personal level , at the expense of another person or organization. It results in willful manipulation, fabrication, or hiding of facts, details, or act to mislead or fool people, institutions, or systems. Fraud can occur in various ways and situations, such as financial transactions frauds , scams in company operations, insurance claims, and investment management. Typically, fraud involves having a goal of misleading others; the offender purposefully provides misleading or inaccurate information through words, deeds, or documentation. The person intentionally provides misleading information, knowing full well that it is erroneous or wrong. The person acts to persuade someone else to act on inaccurate information or to rely on it as fact. Fraud harms the victim or other affected parties in terms of money, reputation, or other areas.

There are various types of fraud there, including:

- **Financial fraud**: this encompasses several illegal activities, such as manipulating economic data, embezzlement, fabrication of company's documents, and unauthorized transactions aimed at illegally obtaining assets or money.
- **Identity theft:** This is described as the misuse of another person's personal details, like bank account details, credit cards, or KYC, to commit fraud or other fraudulent activities.
- **Insurance fraud-** This is defined as claiming false claim or exaggerated insurance claim made to distribute inaccurate benefits or reimbursement to an insurance company.
- **Cyberfraud:** Actions that are performed illegally using digital connections, including virus attacks, phishing endeavors, and online fraudulent payment.
- • **Healthcare fraud:** Charging excessive amounts on bills, giving unnecessary medical procedures or creating a fabrication of medical conditions to commit insurance fraud or medicine fraud to insurance firms or medical systems.

Some strategies and techniques often used to identify fraud are the following.

- **Internal Controls:** Difficult internal controls and job segregation should be run to minimize the possibility of a fraud. In the future, these

controls must be reviewed and analyzed frequently.

- **Data analytics:** Data analytics techniques outline any trends, abnormalities or outliers in financial data. Data analysis can be automated to spot possible signs of fraud, like repeat payment, odd payments, or abnormalities or expectation patterns. Whistleblower hotlines should be made available as confidential reporting channels to prompt staff members, clients, or other stakeholders to report any aspects of suspicion or concern they have regarding a given possibility of fraud.
- **Fraud risk assessment tests:** They should conduct regular fraud risk assessment tests in order to understand any vulnerability in the system, the current state of controls, and develop mitigation strategies.
- **Financial Statement Analysis:** It is defined as the examining of the balance sheet, cash flow statement, income statement, and other records for any illicit activity that might suggest manipulation or fraud.
- **External Audits:** This calls for employing external auditors to conduct impartial audits to check the veracity and correctness of financial accounts, SOP's , spot any red flags or fraudulent activities, and suggest an unbiased opinion.
- **Data Monitoring and Sampling:** This is putting in alerts for transactions & monitoring mechanisms, it alerts you to examine exceptions, discrepancies, anomalies, and to for any forensic inconsistencies, , reconstruction.
- **Interviews with Management and Staff:** To obtain critical information, evaluate trustworthiness, and find possible red flags , interview those who are involved in pertinent procedures or who may be presumed of fraud.
- **External Aid :** The investigators can speak with attorneys, forensic accountants, or fraud analyst who focus on fraud identification and investigation. They possess the knowledge, resources, and tools needed to detect fraudulent frauds and help take right action.
- **Red flags** may differ based on the type of business, industry, or particular situation, but the following are typical examples:
- **Inadequate Internal Controls**: Fraud may be made possible by week internal controls, a lack of work segregation, or a poor control environment.
- **Unusual Financial Trends:** If there are notable variations or discrepancies in financial statistics, such as abrupt shifts in growth rates, liquidity, or profitability, then it requires further research. Abnormalities in financial statements, unexplained modifications, fake transactions, or discrepancies between reported data and supporting paperwork can indicate financial manipulations.
- **Problems with cash flow:** Due to presence of frequent negative cash flows, big or sudden cash withdrawals, or issues in paying expenses can all be signs of manipulation.
- **Inappropriate Accounting Practices:** The fraudulent manipulation may be masked by showing less revenue recognition, incorrectly capitalizing expenses, or using voodoo accounting techniques that show fake results.
- **A conflict of interest** or self-dealing may be indicated by strange transactions involving link parties, such as executives or stockholders, which are significant and happen without the required disclosure or at prices below market value.
- **Insider trading or market manipulation:** They can be tips indicating insider trading, unusual price movements in the absence of conclusions, or unusual trading as evidence of market manipulation, or market fraud. Insufficient cases of bribery, corruption, or conflict of interest or non-obedience of rules and regulations may be considered as ethical breaches and red flags of fraudulent activity
- **Whistleblower Reports or Employee Complaints:** Allegations of improperness, workplace illness and anonymous tips about possible fraud will have to be taken seriously and investigated. Lifestyle Odd excessiveness or lavish lifestyle to a degree that is more than an individual can comfortably afford materially may be a lead to defalcation or financial pilferage.

It is important to keep in mind that not all red flags will mean that there is fraud going on. However, they are used as pointers toward deeper inspection and examination to find out whether the deception is occurring or wrongdoings are in place.

Various financial indicators, such as profitability, liquidity and leverage ratios are some of the key

indicators used to evaluate the various performances of a firm in relation to financial health. The profitability ratios determine the power of net profitability and return to the investors of an organization, whereas the liquidity ratios quantify the ability of a company to meet its debts. Leverage ratios study the debt levels of a business and the financial leverage in order to understand the risk being faced and the amount of effect it may have on the owner of shares. These measures allow one to understand the general financial situation of the firm.

The profitability ratio provides useful data about the effectiveness and the effectiveness of the activities of an organization. Common profitability ratios include the gross profit margin, the operational profit margin and net profit margin. These ratios are used to evaluate the ability of a business to maintain its prices strategy, ensure cost control and generate profitability on sales. They are crucial in calculation of profitability trends over the period, calculation of use of performance base against industries and identification of areas that require improvement.

Liquidity ratio analysis is focused on the main subjects of the ability of a commercial enterprise to fulfill its obligations in time and the short-term fiscal subjects. Important liquidity ratios are the quick and current ratios. The ratios measure the ability of the company to utilize its very liquid or current assets in order to pay off the short-term debt. Monitoring the liquidity ratio will determine whether a company can manage its cash flow, withstand operations and financial challenges, and identify the potential liquidity threats.

Data Analytics in Fraud Examination:

The calculations of ratios show the debt and capital structure of the company. The interest coverage ratio and debt-to-equity ratio are some examples of the leveraging ratios that are normally used. These analyses provide insights on the debt financing of the company. The profitability, liquidity, and leverage ratios are important areas to be understood by investors, banking institutions, and the management in order to determine the financial performance, solvency, and the risk profile of a company. Analysis of the ratio provides stakeholders with well-informed decisions on loans, opportunities in the investments market, and do strategic planning.

To obtain a detailed grasp of a company's financial status and future, it is important to use these ratios along with other qualitative and quantitative aspects.

In conclusion, ratio analysis is a important method for revealing the health and financial performance of a company's structure. Although ratio analysis has limitations, it can provide valuable insights into a company's financial health and aid stakeholders in making informed decisions regarding lending, investments, and general business plans.

Literature review:

The company’s individuals have performed financial statement manipulation excessively to inflate the books of accounts. (Beneish, 1999). Profits are shown by either showing current term liabilities in the long term or by showing high income from the sales of goods or services and adding them to the books before the transaction takes place. Such activities have been painful for auditors, as they would find it challenging to identify such malpractices, and such scams provide an excellent opportunity for forensic accountants to showcase their skills.(Hamdan, 2019). Forensic accounting is the field of accounting that encompasses the use of accounting skills, litigation, information technology, psychology, data analytics, and a good understanding of the internal controls of a company and its management; thus, it is a perfect solution to tackle financial fraud.(Alabdullah et al., 2013).

Forensic accountants have been proven to be efficient in identifying fraud, not only in the corporate sector but also in the banking sector.(Ewa et al., 2020). Forensic accountants have an arsenal of various tools and techniques to identify red flags and anomalies in financial statements.(Rangoonwala, 2020). Various tools, such as Microsoft Excel, CaseWare IDEA, and Glavanize, help forensic accountants identify anomalies apart from financial data analysis techniques.(Dalnial et al., 2014). The previous studies have identified the strengths of forensic accountants, finding it to be a highly growing field with very high future demand. In contrast, discussions on weaknesses highlight the absence of rules & regulation in the field, a lack of awareness,

Economic Sciences
https://economic-sciences.com
ES (2025) 21(5S), 56-65| ISSN:1505-4683

and the absence of a single investigation method that can be generically applied. This is due to the nature of cases are unique, and unique investigations methods depending on the investigator, leading to different approaches. (Alshurafat et al., 2021)

Forensic accountants use various analytical methods to investigate financial manipulation and scams and these methods have evidenced effective, mainly due to their derivation from deep analysis of numerous companies.(Altman, n.d.). These techniques use data analytics methods and have a significant outcome in terms of detecting scams.(Farooq Aziz, 2023). Data analytics is not new in the domain of forensics, as auditors have been using various techniques to identify deviations and thus prevent and timely detect red flags. (Chu & Yong, 2021). The use of data analytics is becoming essential as the complexity of data increases, making analysis difficult. The terminology "Big Data" has become an integral part of accounting. Therefore, it's the need of the hour to include such techniques for investigation as they will help in identifying hidden patterns and anomalies.(Earley, 2015)

Several techniques are available, such as the Altman Z-score, Benish M-score, James modified C-score, Ohlson O-score, and J model. Various studies have proven that these techniques help detect manipulation in financial statements.(Kukreja et al., 2020). These studies have benefited investigators and investors who have used them for investigations and by investors for identifying companies worth investing. in (Sharma & Panigrahi, 2012). These techniques comprise Data Mining methods, which make them more efficient and effective in detecting manipulations in financial statements. However, they also face some challenges, but can still be applied.(Dalnial et al., 2014).

These techniques also help identify bankruptcies or the possibility of upcoming bankruptcies by analyzing financial data. The same can be beneficial for investors, as investing money in such companies can have a positive impact and thus impact the economy. (Rangoonwala, 2020). Of all these techniques, the Altman Z-score has proven to be more effective than other models. The Atman score has various ratios and is modified according to the firm's nature and market segmentation. Based on the score obtained, the company is considered to be in the stress, green, or safe zone.(Kanchanapalli et al., n.d.).

The Piotroski F-Score is a nine-point composite indicator that evaluates the fundamental strength of a company using publicly reported financial statements. It was introduced by Joseph D. Piotroski (2000) to identify financially strong value stocks. Each of the nine tests contributes one point when met, and zero otherwise, giving a score between 0 and 9. Higher scores indicate stronger fundamentals and a greater likelihood of robust performance, while lower scores can flag potential weakness.

How the F-Score Is Computed (Nine Signals):

A) Profitability (4 signals):
1) Positive Return on Assets (ROA): ROA > 0.
2) Positive Operating Cash Flow (CFO): Net cash from operating activities > 0.
3) ΔROA > 0: ROA is higher than the prior year.
4) Accruals: CFO > Net Income.
B) Leverage, Liquidity & Source of Funds (3 signals):
5) Δ Leverage ↓: Decline in long-term debt/assets ratio.
6) Δ Current Ratio ↑: Improvement in current ratio.
7) No new shares issued.
C) Operating Efficiency (2 signals):
8) Δ Gross Margin ↑: Improvement in gross margin.
9) Δ Asset Turnover ↑: Improvement in asset turnover.

The previous empirical research encourages the usefulness of the Piotroski F-Score. Piotroski (2000) showed that high-score companies outperformed low-score companies, associated accounting signals to returns. Krauss, Krüger, and Beerstecher (2015) confirmed the effectiveness of the F-Score strategy when analyzed from an investor's perspective. Abdioğlu (2024) showed in the Turkish market that leverage and profitability drive the F-Score, while Rao, Namutebi, Anyait, Varma, and Reddy (2024) showed its investment importance in emerging markets. Collectively, these studies confirm the score's academic and practical importance.

Research Methodology:

ALTMAN'S Z-SCORE FOR BANKRUPTCY PREDICTION:

The Z-score model was created in 196 by Edward Altman, a finance professor at New York

Economic Sciences
https://economic-sciences.com
ES (2025) 21(5S), 56-65| ISSN:1505-4683

University's Leonard N. Stern School of Business, is a financial tool used to forecast a company's bankruptcy probability. The economic stability of any company can be accurately analyzed and calculated using this strategy. When determining the score, the activity ratios, profitability, risk, and liquidity are all considered. This credit-marking model is one of several already in use that combine a limited number of factors with measurable financial indicators to help anticipate whether a company will experience financial failure or enter bankruptcy.

The Z-score has improved over time and is now considered one of the most accurate indicators of bankruptcy. Currently, many analysts employ this score because of its many uses. To reassess his methods, Altman studied 86 troubled businesses between 1969 and 1975, 110 bankrupt companies between 1976 and 1995, and 120 bankrupt enterprises between 1996 and 1999.

The Altman score uses a formula to analyze financial health, which varies from sector to sector.

For Instance, it has been modified for the following sectors as required

- Manufacturing Firms
- Private firms
- Non-manufacturing firms

Manufacturing Firms (Z):

For a manufacturing firm the formula has been modified as

Z Score formula = (1.2 x A) + (1.4 x B) + (3.3 x C) + (0.6 x D) + (0.999 x E):

- Ratio A is defined as working capital divided by total assets.
- Ratio B has been calculated by dividing Retained Earnings by total assets
- Ratio C is Earnings before interest and task payment divided by total assets
- Ratio D is the value derived by dividing the equity's market value by total assets
- Ratio E is calculated by dividing total sales by total assets.

Private firms (Z')

For a private firm, the formula has been modified as

Z' Score formula = (0.717 x A) + (0.847 x B) + (3.107 x C) + (0.420 x D) + (0.998 x E)

- Ratio A is calculated by deducting current liabilities from current asset and dividing it by total asset
- Ratio B is calculated by dividing Retained Earnings by Total Assets
- Ratio C is calculated by Dividing Earnings Before Interest and Taxes by Total Assets
- Ratio D is the result of dividing the Book Value of Equity by Total Liabilities
- Ratio E is obtained by dividing Sales by Total Assets

Non-manufacturing firms (Z''):

For a non-manufacturing firm that is operational in a developed market, the formula has been updated and shown as

Z'' score formula = (6.56 x A) + (3.26 x B) + (6.72 x C) + (1.05 x D):

For a non-manufacturing firm that is operational in an emerging market, the formula has been updated and shown as

Z'' = 3.25 + (6.56 x A) + (3.26 x B) + (6.72 x C) + (1.05 x D):

- Ratio A is calculated by deducting current liabilities from current assets and dividing by total assets
- Ratio B is calculated by dividing Retained Earnings by Total Assets
- Ratio C is calculated by Dividing Earnings Before Interest and Taxes by Total Assets
- Ratio D is the result of dividing the Book Value of Equity by Total Liabilities

A company's Altman Z-score of less than 1.8 suggests that it may be on the verge of bankruptcy or may probably file for bankruptcy. In contrast, a score of more than 3 indicates that it is doing well financially and has little possibility of filing for bankruptcy. Investors should consider companies with a score of three or more. Businesses that score between 1.8 and 2.99 are considered financially solid and are less likely to declare bankruptcy.

Research shows that models predicted bankruptcy with 72% accuracy in foretelling bankruptcy two

Economic Sciences
https://economic-sciences.com
ES (2025) 21(5S), 56-65| ISSN:1505-4683

years ahead of time, with 6% of predictions being falsely positive. Over time, it grew and demonstrated 80–90% dependability. The initial intent was for industrial firms with over 10 lakhs in assets to use the system. This model has been adjusted to accommodate non-manufacturing and emerging market enterprises. It performed a fantastic job of separating insolvent enterprises from non-bankrupt enterprises.

Data Collection:

The Objective of this study is to analyse the data-driven insights of Sun Pharma Ltd with the help of the Altman Z score . Financial Data was obtained from the Internet, and various values were calculated until the year 2024 , along with the previous years, to understand the overall score.

Data Analysis

For the year 2024, the calculation is as follows

{Net Working Capital / Total Assets} X 1.2

(26,491 / 85,463) X 1.2 = 0.37196

{Retained Earnings / Total Assets} X 1.4

(9648 / 85,463) X 1.4 = 0.083

{EBIT / Total Assets} X 3.3

(11,582 / 8,5463) X 3.3 = 0.447

{Market Cap / Total Liabilities} X 0.6

(4,07,491 / 18,357) X 0.6 = 13.318

{Total sales / Total Assets} X 0.999

(48,497 / 85,463) X 0.999 = 0.566

Z = 0.371 + 0.083+ 0.447 + 13.318 + 0.566= 14.78

The calculated Altman Z-Score of 14.78 signifies an exceptionally strong financial position. It is far above the 2.99 threshold, placing the firm firmly in the safe zone.
This shows negligible bankruptcy risk and high financial stability.
The result demonstrated strong profitability, liquidity, and efficient asset utilization. Overall, the firm shows strong financial health and long-term sustainability. The Altman Z-score should be used along with other ratios, as trusting solely on it for decision-making may not be a wise decision.

The Altman Z score for the last 8 years was analyzed in a similar manner.

Year Wise	2024	2023	2022	2021	2020	2019	2018	2017
Altman Z Score	14.86	11.04	11.33	10.31	8.87	7.81	6.64	7.25

Fig 1.1

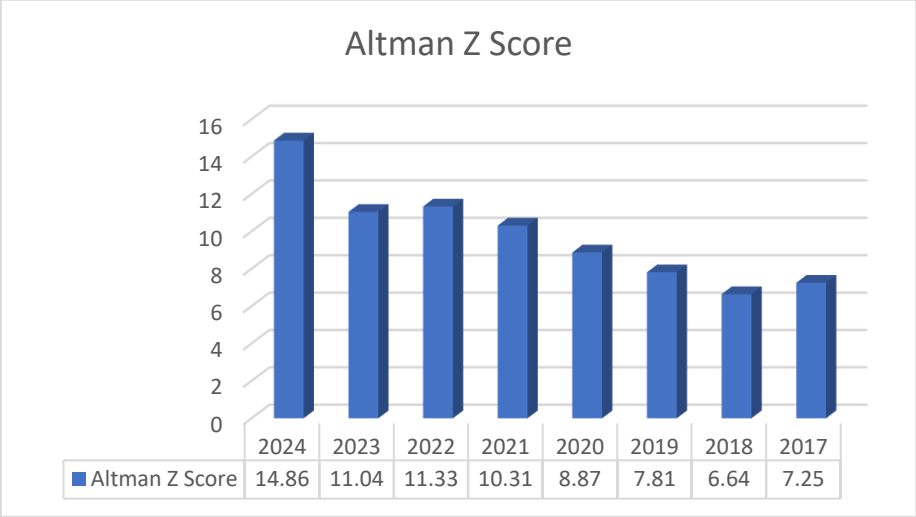

Fig 1.2

Discussion: Altman Z-scores calculated for last 8 years, we can extract the following conclusions:

Year 2024: The Altman Z-Score of **14.86** shows a good level of financial stability and operational

Economic Sciences
https://economic-sciences.com
ES (2025) 21(5S), 56-65| ISSN:1505-4683

strength. The firm reveals high profitability and very little bankruptcy risk.

Year 2023: With a score of **11.04**, the company remains in a very secure financial position. Continued improvement in profitability and utilization of assets adds to this position.

Year 2022: A Z-Score of **11.33** signifies strong financial position. The slight rise from the previous year indicates sustained efficiency and stable performance.

Year 2021: The score of **10.31** implies consistently safe financial position. Positive operating income and controlled leverage showcase the firm's strong solvency profile.

Year 2020: At **8.87**, the companies maintain a solid position within the safe zone. Despite possible economic challenges, profitability and liquidity remained stable.

Year 2019: The Z-Score of **7.81** reflects significant strong financial strength, though slightly lower compared to previous years. The company's fundamentals remained strong, with manageable risk exposure.

Year 2018: A value of **6.64** signifies a financially secure but reasonably moderate position. The firm is focused on improving operational efficiency and profit margins.

Year 2017: With a Z-Score of **7.25**, the company demonstrated good financial health and low bankruptcy risk. This period marks the foundation for subsequent increasing financial improvement.

Overall, these figures indicate the company's financial health over the years, as shown in Fig. 1.2. To gain a clear understanding, it is essential to analyze the reasons behind these changes, consider industry benchmarks, and assess other financial indicators in addition to the Altman Z-score.

Trend Summary:

The year-wise analysis of Altman Z-Scores from 2017 to 2024 bares a clear and consistent increasing trajectory in the companies' financial stability and operating performance. Starting from a strong score of 7.25 in 2017, the score demonstrates steady improvement, reaching at 14.86 in 2024. This advancing increase signifies continuous improvement in profitability, liquidity, and solvency ratios over the time. The persistent growth in Z-Scores suggests effective financial management, strong leverage policies, and effective asset utilization. Overall, the trend implies a transition from a position of strong stability to one of exceptional financial robustness and negligible distress risk, highlighting the firm's strategic and operational excellence across the observed period.

Apart from Altman's z-score, Piotrowski's-F-score is deployed by investors and analysts to recognize companies that are worth investing in, and a similar computation is done to calculate the Piotrowski's-F-score for the Sun Pharma Company.

Detailed Criterion-wise Piotroski F-Score Table:

Criterion	**2024**
Positive Net Income	1
Positive Operating Cash Flow	1
Higher Return on Assets (ROA)	1
Quality of Earnings (CFO > NI)	1
Lower Leverage (Debt/Assets ↓)	1
Higher Current Ratio	1
No New Shares Issued	1
Higher Gross Margin	1
Higher Asset Turnover	1
Total Score	**9**

The following table presents the detailed 1/0 scores for each of the nine Piotroski F-Score criteria for the Year 2024, along with the total score for each component.

Economic Sciences
https://economic-sciences.com
ES (2025) 21(5S), 56-65| ISSN:1505-4683

Fig 1.4

The Piotroski F-Score for the previous 8 years was calculated in the same way.

Year Wise	2024	2023	2022	2021	2020	2019	2018	2017
Piotroski F-Score	9	5	8	7	8	7	4	5

Fig 1.5

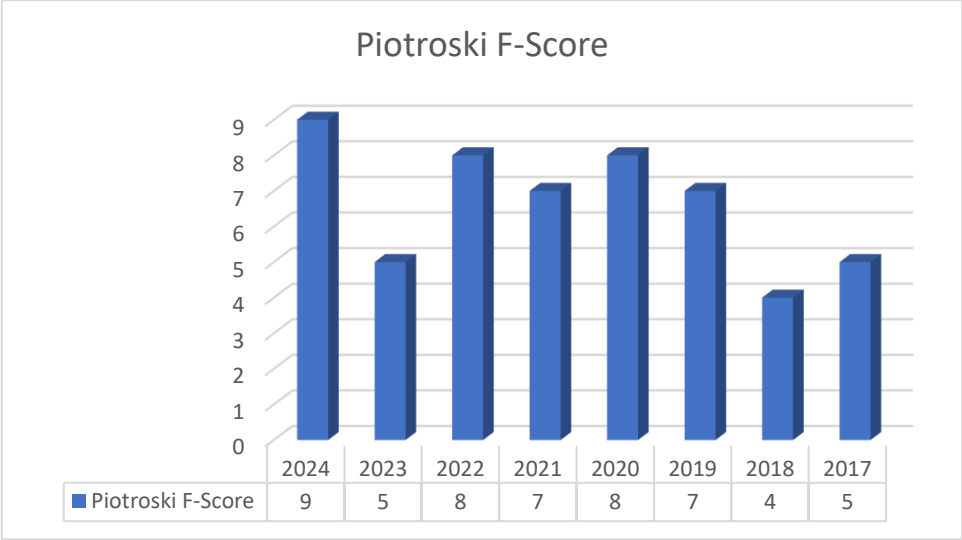

Fig 1.6

Annual Piotrowski F-Score (Bar Chart)

Trend Summary:

Piotroski F-score analysis for the period of 2017-2024 indicates a change in firm fundamentals (i.e., improvements) regarding both financial strength and operating efficiency over time. The firm's initial F-score was relatively good in 2017 at 5 which indicates fairly good financial health; and the score has generally increased each year after that. The periods of time when the score fluctuated between 4 and 8 indicate fluctuations in profitability, liquidity and how the firm manages its leverage throughout different times. More importantly, in 2024 the firm's F-score peaked at 9, representing an extremely positive view of the firm's financial performance, cash flow, and earnings quality. As such, the trend upward of the past few years illustrates the improvement in the firm's fundamental characteristics as well as their financial discipline and the confidence investors have in the firm.

Conclusion:

The Altman Z-Score and Piotroski F-Score calculations for 2017 through 2024 are indicative of a comprehensive assessment of the company's financial health, operating efficiency, and overall company performance. The Altman Z-Score demonstrated an upward trend over time with the highest score at 14.86 in 2024 and the lowest score at 7.25 in 2017; indicating a significant increase in the companies' ability to be profitable, liquid and solvent. The consistent upward trend is also indicative of the company's ability to effectively manage their financial resources by utilizing assets and maintaining sufficient capital, thus reducing the likelihood of the company declaring bankruptcy.

Suggestions:

The use of both the Altman Z-Score and the Piotroski F-Score provides an opportunity for analysts to obtain insight in regard to a company's overall financial health as well as operational efficiency. However, limiting analysis to either one of these models will likely lead to a limited and incomplete assessment of the company's financial health. As previously stated, each of these models are primarily based on accounting information and therefore do not necessarily consider the impact of changes in the market environment, corporate governance practices, or external economic events

that can affect the financial performance of a company. In order to provide a more comprehensive assessment of a company's financial health, future studies are encouraged to utilize a multi-model approach which incorporates other diagnostic models that include the Ohlson O-Score, Beneish M-Score, and Modified C-Score.

Utilizing the Ohlson O-Score will improve the predictive ability of the model by estimating the likelihood of a company filing bankruptcy utilizing a logistic regression model that includes a variety of firm specific characteristics (size, leverage, liquidity, etc.) as well as performance metrics. On the other hand, the Beneish M-Score will identify possible financial statement manipulation through the incorporation of accrual-based ratios providing insight into the validity of the reported financial statements. Additionally, the Modified C-Score will incorporate these factors and analyse how they relate to managerial incentives, discretionary accruals and other corporate governance issues that can influence the quality of a company's financial reporting.

To create a more complete picture of a company's financial health and identify possible red flags associated with financial manipulation, researchers are encouraged to supplement their quantitative analysis with qualitative assessments, including management's analysis, the company's environmental social governance (ESG) performance and its position within the current macroeconomic environment. Finally, adding additional advanced data analytic and AI-based tools to help detect patterns of financial manipulation can help reinforce early warnings of potential financial irregularities.

References:

1. Alabdullah, T., Alfadhl, M. M. A., Yahya, S., & Rabi, A. (2013). The Role of Forensic Accounting in Reducing Financial Corruption: A Study in Iraq. *The International Journal of Business and Management*, *9*. https://doi.org/10.5539/IJBM.V9N1P26
2. Alshurafat, H., Shbail, M. O. A., & Mansour, E. (2021). Strengths and weaknesses of forensic accounting: An implication on the socio-economic development. *Journal of Business and Socio-Economic Development*. https://doi.org/10.1108/JBSED-03-2021-0026
3. Altman, E. I. (n.d.). *The Journal of FINANCE: THE PREDICTION OF CORPORATE BANKRUPTCY*.
4. Beneish, M. D. (1999). The Detection of Earnings Manipulation. *Financial Analysts Journal*, *55*(5), 24–36. https://doi.org/10.2469/faj.v55.n5.2296
5. Chu, M. K., & Yong, K. O. (2021). Big Data Analytics for Business Intelligence in Accounting and Audit. *Open Journal of Social Sciences*, *9*(9), Article 9. https://doi.org/10.4236/jss.2021.99004
6. Dalnial, H., Kamaluddin, A., Sanusi, Z. M., & Khairuddin, K. S. (2014). Detecting Fraudulent Financial Reporting through Financial Statement Analysis. *Journal of Advanced Management Science*, *2*(1), 17–22. https://doi.org/10.12720/joams.2.1.17-22
7. Earley, C. E. (2015). Data analytics in auditing: Opportunities and challenges. *Business Horizons*, *58*(5), 493–500. https://doi.org/10.1016/j.bushor.2015.05.002
8. Ewa, U., Uket Eko, E., Adebisi, A. W., & Moses, E. J. (2020). Evaluation of Forensic Accounting Techniques in Fraud Prevention/Detection in the Banking Sector in Nigeria. *Article in International Journal of Finance and Accounting*, *2020*(3), 56–66. https://doi.org/10.5923/j.ijfa.20200903.02
9. Farooq Aziz. (2023). Data analytics impacts in the field of accounting. *World Journal of Advanced Research and Reviews*, *18*(2), 946–951. https://doi.org/10.30574/wjarr.2023.18.2.0863
10. Hamdan, M. W. (2019). The Role of Forensic Accounting in Discovering Financial Fraud. *International Journal of Accounting Research*. https://doi.org/10.35248/2472-114x.18.6.176
11. Kanchanapalli, J., Jagannayaki Professor, D. K., & Dept, M. (n.d.). *"ALTMAN 'Z' SCORE MODEL"-A TOOL FOR FINANCIAL DISTRESS "Optimum Portfolio Construction of IT Sector using Capital Asset Pricing Model"; View project "ALTMAN 'Z' SCORE MODEL"-A TOOL FOR FINANCIAL DISTRESS*. https://www.researchgate.net/publication/360044848
12. Kukreja, G., Gupta, S. M., Sarea, A. M., & Kumaraswamy, S. (2020). Beneish M-score and Altman Z-score as a catalyst for corporate fraud detection. *Journal of Investment Compliance*, *21*(4), 231–241. https://doi.org/10.1108/joic-09-2020-0022
13. Rangoonwala, N. (2020). Evaluation of various Bankruptcy Prediction Models. In *An*

Interdisciplinary Journal of Navrachana University (Vol. 2). www.nuv.ac.in

14. Sharma, A., & Panigrahi, P. K. (2012). A Review of Financial Accounting Fraud Detection based on Data Mining Techniques. *International Journal of Computer Applications*, *39*(1), 37–47. https://doi.org/10.5120/4787-7016
15. Piotroski, J. D. (2000). Value investing: The use of historical financial statement information to separate winners from losers. Journal of Accounting Research, 38(Supplement), 1–41. https://doi.org/10.2307/2672906
16. Krauss, C., Krüger, T., & Beerstecher, D. (2015). The Piotroski F-Score: A fundamental value strategy revisited from an investor's perspective. FAU Discussion Papers in Economics, No. 13/2015. Friedrich-Alexander University Erlangen-Nürnberg.
17. Abdioğlu, N. (2024). On the financial determinants of the Piotroski F-Score (Evidence from Borsa İstanbul firms). Journal of Business, Economics and Finance Studies, 2(1), 45–59. https://dergipark.org.tr/en/download/article-file/3900676
18. Meda Srinivasa Rao, M., Namutebi, M. O., Anyait, M. B. F., Varma, V. V., & Reddy, D. D. S. (2024). Piotroski F-Score model in investment. International Journal of Advanced Multidisciplinary Research Studies, 4(6), 296–300.
19. Reliance Infrastructure Limited. (2025). Annual Report 2024–25. Retrieved from https://www.relianceinfra.com