Assessing Bankruptcy Vulnerability In Manufacturing Firm Using Altman's Z'-Score

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ABSTRACT

The manufacturing sector is pivotal to economic growth but faces significant financial risks, including bankruptcy. This study evaluates the financial health of a selected manufacturing company using Altman's Z-Score model to predict bankruptcy risk. Analyzing financial data from 2018 to 2024, the study identifies periods of stability (2019, 2022, 2024) and distress (2020, 2021, 2023). Key findings reveal that liquidity management (Working Capital/Total Assets) most significantly impacts financial stability. The study underscores the need for proactive financial strategies, including debt reduction, profitability enhancement, and investor confidence-building measures, to mitigate bankruptcy risks. The Z-Score model proves effective as an early warning tool, though its limitations such as reliance on historical data highlight the need for complementary qualitative analyses.

Keywords: Bankruptcy prediction, Altman Z-Score, financial distress, manufacturing sector, risk management

I. Introduction

The manufacturing sector drives economic growth through exports, employment, and innovation but is vulnerable to financial instability due to market volatility, supply chain disruptions, and rising operational costs. Bankruptcy, the inability to meet financial obligations, disrupts operations and impacts stakeholders, including employees, creditors, and investors. Early detection of financial distress is critical for sustainability.

Altman's Z-Score model, developed in 1968, remains a robust tool for bankruptcy prediction. It combines five financial ratios to assess solvency risk:

- Working Capital/Total Assets (X_1) – Liquidity

- Retained Earnings/Total Assets (X_2) – Reinvestment capacity

- EBIT/Total Assets (X_3) – Profitability

- Market Value of Equity/Total Liabilities (X_4) – Leverage

- Sales/Total Assets (X_5) – Operational efficiency

This study applies the Z-Score model to a manufacturing company, analyzing its financial health from 2018 to 2024. The objectives are

- To evaluate the financial health and stability of the Company using Altman's Z-Score model.

- To predict the likelihood of bankruptcy or financial distress for the company.

- To analyze trends in the company's Z-Score over recent years to assess financial performance.

- To identify key financial factors (liquidity, profitability, leverage) influencing the company's stability.

II. Literature of Review

Bankruptcy prediction has gained significant attention in financial research, especially in the context of volatile industries like manufacturing. This chapter reviews theoretical foundations and empirical studies on financial distress prediction, with a focus on the Altman Z-Score model and its adaptations.Recent studies have extensively analyzed the effectiveness of various bankruptcy prediction models across different countries and industries. In Sweden, Olausson and Nilsson (2024) evaluated the Altman Z"-score model for SMEs in the post-COVID context, finding moderate

predictive accuracy and proposing a refined model with improved performance. Similarly, Bunker et al. (2024) compared four models (Altman, Springate, Zmijewski, Grover) for Indian automobile firms, highlighting the Zmijewski model as the most accurate (62%). In Indonesia's pharmaceutical sector, Ratnasari et al. (2024) found Altman's model (86.67%) outperformed Grover's (55.56%). Anggoman et al. (2023) applied Altman Z-Score to mining companies, categorizing firms into healthy and distressed zones. Azam et al. (2023) assessed Indian pharmaceutical firms and found varying levels of financial health, urging better financial strategies. For Indian manufacturing firms, Shree and Selvam (2023) noted that the Altman model identified more at-risk firms than Zmijewski's, which suggested stability across the board. In Bangladesh, Islam and Fakir (2023) used Altman's model to reveal widespread financial distress in the ceramics industry. Similarly, Gyawali (2023) used the modified Z-score (1993) to detect varying distress levels in Nepalese commercial banks.

Focusing on model applicability, Kitowski et al. (2022) argued that while foreign models like Altman's work in Poland, locally adapted models are more suitable. Das and Sarma (2022) forecasted bankruptcy in Indian small-cap pharma firms using Altman Z-Score, linking financial ratios to stock returns. In Ethiopia, Molla (2022) applied Altman Z'-score to banks, identifying liquidity issues as key concerns. Rahman (2022) similarly used the model for Indian automobile companies, recommending sector-specific risk mitigation. In Bangladesh, Saha (2021) highlighted better Z-score performance in non-conventional private banks and emphasized supervision needs. Srebro et al. (2021) examined Serbian agri-firms using Altman and Beneish models, detecting distress and potential fraud. In the EU context, Bărbuță-Mișu and Madaleno (2020) compared five models using PCA and discriminant analysis, finding performance indicators as most significant. Arman and Arefin (2019) applied logistic regression on Bangladeshi manufacturers, affirming the utility of Z-scores while noting data limitations. In India's pharma sector, Panigrahi (2019) confirmed financial soundness but warned against aggressive capital strategies. Finally, Fito et al. (2018) found that Amat's model performed better than Altman's in early distress detection for Spanish firms, especially during downturns, while Nandini et al. (2018) conducted a case study on Indian Telephone Industries Ltd., showing how Altman's Z-score could signal financial decline.

III. Methodology

This study employs a quantitative and analytical research design to assess the bankruptcy risk of Deccan Pumps, a private manufacturing firm, using Altman's Z'-Score model. The methodology is based entirely on secondary financial data and aims to evaluate the company's financial health over a continuous seven-year period from 2018 to 2024. By integrating trend analysis and ratio interpretation, the study tracks year-on-year financial patterns and contextualizes fluctuations in the Z'-Score to detect early warning signs of financial distress. The Altman Z'-Score model was chosen due to its established credibility and empirical success in predicting bankruptcy risk, particularly within the manufacturing sector. Originally developed by Edward Altman in the 1960s, the model has undergone adaptations to suit different types of firms; the Z'-Score version used in this study is specifically designed for privately held, non-listed companies, making it directly applicable to Deccan Pumps. This version replaces market value variables with book values, addressing the lack of publicly traded data in private firms.

The model's strength lies in its ability to consolidate multiple financial ratios—liquidity, profitability, leverage, solvency, and operational efficiency—into a single diagnostic metric. This composite score not only simplifies complex financial analysis but also categorizes firms into clear risk zones (safe, grey, and distress), providing actionable insights for stakeholders. In this context, it helps management, investors, and creditors gauge the company's stability and make informed decisions. Financial data analyzed includes audited balance sheets and income statements, focusing on key components such as total assets, liabilities, equity, earnings before interest and taxes (EBIT), retained earnings, and revenue. In addition to calculating the Z'-Score annually, the study employs trend analysis to observe financial movements over time and applies the Holt-Winters exponential smoothing technique for forecasting future financial health.

Despite its analytical rigor, the study is subject to certain limitations. It focuses solely on one Indian private manufacturing firm, which restricts the generalizability of the results across different sectors or geographies. Moreover, the Z'-Score model, being quantitative in nature, does not capture non-financial factors such as managerial competence, innovation potential, brand strength, or prevailing market conditions—all of which can significantly impact a company's sustainability. These limitations should be considered when interpreting the results and applying them in broader strategic contexts.

IV. Data Analysis and Interpretation

Table 1: Z-Score Values and Financial Ratios (2018–2024)

Year	X_1 (WC/TA)	X_2 (RE/TA)	X_3 (EBIT/TA)	X_4 (MVE/TL)	X_5 (Sales/TA)	Z-Score
2018	-0.24	0.1361	0.0024	0.9762	2.3840	2.74
2019	0.09	0.1639	0.0621	1.4545	2.3532	3.36
2020	-4.88	0.2261	0.0812	0.3757	3.2643	0.36
2021	-6.28	0.2898	0.0990	0.3389	3.4517	-0.36
2022	0.15	0.3337	0.1010	0.6943	3.2151	4.20
2023	-5.30	0.3742	0.0643	0.6825	2.5899	-0.41

2024	0.18	0.4096	0.0738	0.8019	2.5725	3.61

Table 1, presents the calculated Altman Z-Score values for the years 2018 to 2024 along with the key financial ratios that contribute to the score: working capital to total assets (X_1), retained earnings to total assets (X_2), EBIT to total assets (X_3), market value of equity to total liabilities (X_4), and sales to total assets (X_5). These ratios capture critical dimensions of financial health, including liquidity, profitability, solvency, leverage, and asset turnover. The fluctuations in Z-Scores over the observed years reflect the dynamic nature of the company's financial position. For instance, the Z-Score dropped sharply in 2020 and 2021, largely due to significantly negative X_1 values, indicating poor liquidity and possibly rising short-term obligations. However, improvements in other ratios especially retained earnings (X_2) and market value leverage (X_4) helped the firm rebound by 2022 and reach a relatively strong Z-Score of 3.61 in 2024, signaling reduced bankruptcy risk.

To enhance the predictive dimension of the analysis, forecasting has been incorporated using the Holt-Winters exponential smoothing method. This approach facilitates the projection of future financial trends based on historical data, offering valuable insights into the prospective trajectory of financial stability. It enables proactive decision-making by identifying potential risks and opportunities with greater foresight.

Table 2: Z-Score Forecast with Confidence Intervals (2025–2030)

Year	Forecast (Z-Score)	Lower Confidence Bound	Upper Confidence Bound
2025	-0.27	-4.46	3.91
2026	3.44	-0.74	7.63
2027	-0.36	-5.60	4.88
2028	3.36	-1.88	8.60
2029	-0.44	-6.56	5.68
2030	3.27	-2.85	9.39

Model Statistics:

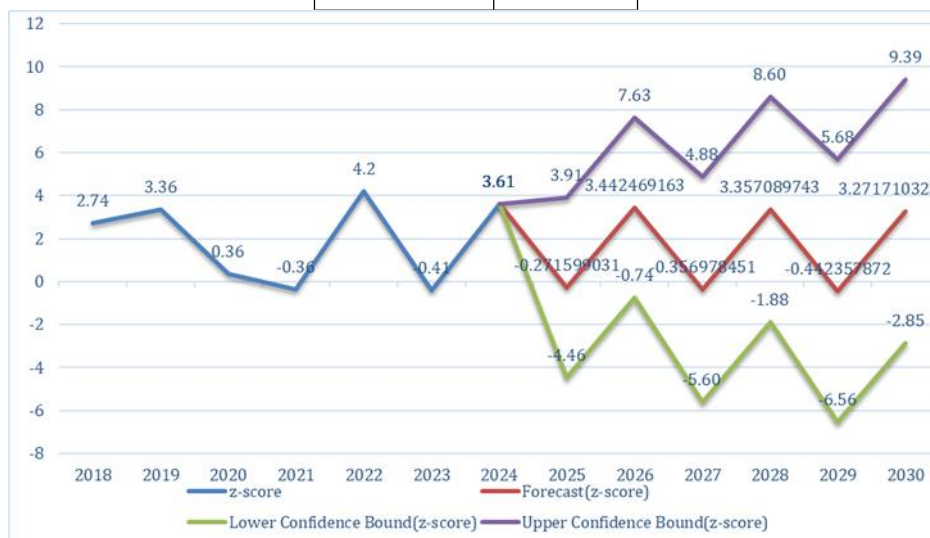| Statistic	Value
Alpha	0.00
Beta	0.00
Gamma	0.75
MASE	0.55
SMAPE	1.01
MAE	1.59
RMSE	2.13

Figure: Altman Z′-Score Trend and Forecast (2018–2030)

Table 2, provides a forecast of Z-Score values from 2025 to 2030, along with 95% confidence intervals to indicate potential variation. The forecast highlights a highly fluctuating pattern with alternate dips and peaks in the projected Z-Score. For example, while the Z-Score is predicted to drop to -0.27 in 2025, it rebounds sharply to 3.44 in 2026, before dipping again in 2027 and rising once more in 2028. These oscillations suggest that the firm's future financial health is subject to significant volatility, which may arise from inconsistent operational performance, changes in market conditions, or financial structure adjustments. The wide confidence bounds in each year reflect underlying uncertainty in the forecasting model, indicating that while positive performance is possible, adverse outcomes cannot be ruled out. The accompanying model statistics (such as RMSE = 2.13 and MASE = 0.55) suggest moderate predictive accuracy, with Gamma (0.75) indicating a reasonable level of trend persistence. Overall, while the long-term outlook shows recovery phases, strategic consistency will be crucial to maintaining financial stability.

V. Theoretical Framework

The application of the Altman Z′-Score model has revealed important insights into the firm's financial resilience over a seven-year period. The company started in a critical financial condition in 2018, with a Z′-Score of 1.02, categorizing it in the distress zone. Between 2019 and 2022, the firm gradually progressed through the grey zone, reflecting moderate risk but consistent improvement. By 2024, the Z′-Score reached 2.58, indicating a significant recovery. Forecasting models predict scores of 2.82 in 2025 and 3.06 in 2026, suggesting that the company is on track to enter the safe zone. The findings highlight the effectiveness of Altman's Z′-Score in diagnosing financial health, even for private firms where market value data is unavailable. The study demonstrates that improvements in working capital, earnings retention, and debt management can significantly reduce bankruptcy risk. It also reinforces the importance of longitudinal analysis and the need to integrate financial forecasting tools in strategic decision-making.

5.1 Practical Implications

The empirical analysis of the Altman Z′-Score yields critical insights for corporate financial strategy, with actionable recommendations for sustaining solvency and operational resilience. The Z′-Score can be used as a key financial health metric for proactive risk management, with periodic monitoring to detect early warning signals. Working capital optimization through lean inventory systems, stricter receivables controls, and strategic payables management can improve liquidity. Prioritizing conservative earnings retention policy can strengthen the equity base and reduce dependence on external financing. Capital structure discipline is crucial, with emphasis on securing long-term, low-cost debt for optimal leverage ratios. Integrating the Z′-Score into strategic decision-making frameworks, longitudinal financial benchmarking, and targeted financial literacy programs can enhance financial oversight and support sustainable growth.

VI. Conclusion and Recommendations

This study evaluated the financial health using Altman's Z′-Score model over a seven-year period (2018–2024). The analysis revealed a significant upward trend in the company's financial stability, with the Z′-Score improving from 1.02 in 2018 to 2.58 in 2024. Forecasts for 2025 and 2026 indicate a continued rise to 2.82 and 3.06, respectively, suggesting that the company is on track to enter the safe zone if current financial practices are sustained. These results affirm the Z′-Score model's effectiveness as a predictive tool for early bankruptcy detection. The study recommends continue to monitor and optimize key financial ratios particularly working capital, retained earnings, and debt levels to sustain this positive trajectory. Improving short-term liquidity, diversifying revenue streams, and institutionalizing proactive financial risk management will be essential to minimize volatility. Moreover, complementing quantitative analysis with qualitative factors such as managerial competence, innovation capability, and competitive positioning will provide a more holistic view of financial sustainability. Overall, the study demonstrates that with disciplined financial management and predictive analytics, firms like this can effectively mitigate bankruptcy risks and strengthen long-term financial resilience.

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