Predicting Financial Distress : An Altman Z-Score Analysis of Logistics Companies in India

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Abstract

Logistics firms are vital to every economy or nation in today's interconnected world since they facilitate the local or international transportation of goods and commodities. Any economy needs to estimate the financial risk connected to this industry. The research employed Altman's Z-score model, a widely used technique in this field, to assess financial distress among 41 logistics firms that are listed on the Indian National Stock Exchange (NSE). This study gathered secondary data from the annual reports of logistics companies between 2019 and 2023 in order to calculate various ratios that are useful in determining whether or not a company is financially distressed after using the Z-score. The data for this study were analyzed using a variety of statistical techniques, including logistic regression analysis and descriptive statistics, as part of a quantitative research strategy. The studies indicated that the Altman Z-score model is a useful tool for assessing the degree of financial crisis that logistics companies listed on the Indian NSE are facing. It is possible to say that this instrument is reliable enough to predict the financial troubles of logistic enterprises, given its 96.6% accuracy rate.

Keywords : logistics companies, Altman Z-score model, national stock exchange (NSE), financial ratios, financial distress

JEL Classification Codes : G01, G11, G17, G33

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In order to keep up with the rapid pace of global trade expansion, there must be efficient movement and distribution of goods and commodities, and this crucial task is facilitated by the logistics industry, which plays an important role both within India and around the world—something that can be clearly seen from its impressive growth rate over recent years. In spite of this growth, such firms have to face several challenges that hinder their success, such as increasing expenses, heavy competition, and an unfriendly economic atmosphere, which can result in financial distress. This makes it necessary for these companies to address these problems in order to continue thriving. To reduce these types of risks effectively, it is recommended that you leverage financial ratios to anticipate potential cases of fiscal instability. Moreover, a common practice in financial analysis is to use different types of financial ratios to determine the liquidity and solvency as well as the overall profitability of a given company. In the late 1960s, Edward Altman established the widely used Altman *Z*-score approach, which utilizes key metrics to predict imminent danger or potential bankruptcy. This study paper focuses on conducting a financial ratio analysis of logistics companies listed on the NSE in India, employing the Altman *Z*-score approach to forecast potential future risks.

The financial ratio analysis of logistics companies listed on the Indian NSE is the primary subject of this study paper. Additionally, Altman's *Z*-score model is used to predict the likelihood of probable future dangers.

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The study has the following goals:

✥ To examine the financial ratios of the last five years' worth of logistics companies registered on the NSE (India).

✥ To forecast the financial distress possibility for these organizations, apply Altman's Z-score model to these financial ratios.

✥ To determine which financial ratios are most important in predicting a financial crisis in India's logistics sector.

✥ To assess the Altman Z-score model's accuracy and reliability in predicting financial instability across a range of logistics entities those are registered on the NSE (India).

The goal of this research study is to evaluate the financial soundness and associated risks of these organizations in order to contribute to the current literature on financial risk management in the logistics industry and to offer beneficial viewpoints. Investors, financial analysts, and policymakers interested in assessing the financial risk associated with logistics companies listed on India's NSE will benefit from this research.

Literature Review

Overview of the Existing Literature

Puro et al. (2019) analyzed 106 hospitals between 2006 and 2017 in this study and concluded that of the two models, Altman Z-score emerged as the most effective predictor of financial distress leading to bankruptcy, but despite this fact that none of the financial ratios in each model could differentiate between bankrupt and non-bankrupt hospitals. Thus, by combining different ratios from all three models, a novel financial distress prediction model can be produced. This study highlights the importance of identifying financial difficulties early on and the suitability of accounting-based models for the healthcare sector.

They are examining data collected from 81 financially distressed companies over eight years using an F-score-based predictive model for financial stress. Rahman et al. (2021) revealed compelling evidence that establishes a significant correlation between the F-score and indications for future financial instability. Their findings support adopting the F-score as a trustworthy instrument for predicting potential financial difficulties. Based on their research, the authors recommended that investors and creditors refrain from investing in or granting credit to companies with a low F-Score (Rahman et al., 2021).

Rebetak and Bartosova (2021) asserted that in today's globalized world, stakeholders must possess a comprehensive comprehension of the firm's financial status and the possible risk of bankruptcy. Financial analysis places a premium on the prediction of bankruptcy, and a number of models, including Ohlson's model and Altman's Z-score, are developed for this exact purpose. The authors examined bankruptcy prediction and financial distress models that are used or developed in Slovakia and assessed their efficacy. However, the fitness of these models differs from country to country and industry to industry, making it necessary to be cautious in their use. Additionally, the authors discovered that Slovakia's non-profit organizations lack any financial distress prediction models (Rebetak & Bartosova, 2021).

To forecast or assess the potential financial distress of diverse companies, researchers have suggested and tested several techniques and models. One common technique is to use linear discriminant analysis (LDA) and support vector machines (SVM) for classification. Santoso and Wibowo (2018) compared these two models along with variable selection techniques with a sample of 186 Indonesian industrial companies. They found that using a dynamic period of $k = 1$ for estimation and applying hybrid stepwise variable selection improved the

prediction accuracy significantly. On the other hand, they also identified that the SVM model with these settings still performed poorly in terms of realization accuracy, which could be enhanced by using different kernels and optimization algorithms.

Regulators, management, and investors should all find it crucial to assess a company's potential financial difficulties. In their study, Waqas et al. (2018) explored the influence of financial parameters and market conditions on utilizing logit regression to estimate financial distress for 290 Pakistani businesses between 2007 and 2016. They found that in contrast to relatively inconsequential ones like market factors, ratios pertaining to cash flow, profitability, liquidity, and leverage are significant markers of business performance. However, the logit model had a low accuracy rate for predicting distressed firms (56.1%) compared to healthy firms (98.5%). The study also acknowledged the limitations of the sample period, the choice of financial ratios, and the logit model itself and recommended incorporating macroeconomic variables in future research.

Developing a model that can predict bankruptcy across different countries and different contexts is an arduous task. Alaminos et al. (2016) took this challenge by developing a logistic regression model based on 12 financial ratios that were selected based on their relevance and availability of 80,000 companies from 40 different countries between the period of 2004 and 2014, and the model achieved a good accuracy of 87.6% when tested on a validation set of 20,000 companies of different countries. This study has certain limitations despite being one of the few that tried to develop a global model for the prediction of bankruptcy using financial ratios. These include the absence of industry-specific variables, the assumption that ratios and bankruptcy risk are linearly related, and the possibility of bias due to problems with data availability and quality.

Models for predicting bankruptcy are crucial instruments for evaluating a company's financial health and averting financial disasters in advance. Lee and Lee (2018) in their study analyzed various financial ratios and bankruptcy prediction models of 30 savings banks that became bankrupt in South Korea during the period 2011 to 2015, and they identified seven important financial ratios that had a significant influence on bankruptcy, such as operating income ratio, liquidity ratio, and total asset ratio. Additionally, they recommended some policy changes to strengthen the financial supervision system, enhance financial companies' information disclosure, and safeguard financial consumers. They also suggested that future research concentrate on growth, profitability, and liquidity factors when creating bankruptcy prediction models.

Cash flow ratios are essential metrics for assessing the health and stability of a company's finances. To what extent are the cash flow ratios able to predict future financial difficulties? The goal of Kamaluddin et al. (2019) study was to particularly investigate this within Malaysian consumer and industrial product companies. The researchers found that although the efficiency ratio did not prove useful, profitable operations and adequate debt repayment capability – measured through the solvency ratio – could indeed signal potential trouble down the road. They didn't include the liquidity ratio in their analysis due to the multicollinearity problem. Additionally, they contended that cash flow ratios are a crucial tool for foretelling financial hardship in Malaysian contexts, offering insightful data to creditors, auditors, managers, investors, and shareholders.

Prediction of financial distress is an important aspect for plantation sub-sector companies as they face various challenges and uncertainties in Indonesia and for any company per say. Sibarani et al. (2021) study endeavors to assess how certain financial ratios shape corporate solvency by investigating 10 companies within the plantation subsector registered on the Indonesia stock exchange. Particularly focusing on six key metrics (ROA, ROE, CR, DAR (CLAR, DER), we analyzed data culled from annual reports via logistic regression analysis to unravel patterns between each metric's performance and overall company health. Ultimately, their results indicate that while some metrics had little influence in shaping financial stability – such as CR or DER – others like ROA or CLAR were significantly tied to heightened levels of fiscal straits. They even applied the Altman model using a *Z*-score to classify the companies such as performance and non-performance groups.

In an analysis of models used to estimate insolvency for businesses listed on the Athens stock exchange, Giannopoulos and Sigbjørnsen (2019) discovered that Altman's model performed worse in predicting bankruptcy

in the years leading up to and including the event than did the *Y* models of Taffler, Grammatikos, and Gloubos. This research implies that Greek-specific models could lower the likelihood of bankruptcy and emphasizes the importance of early and precise identification of bankruptcy signals for businesses to overcome financial difficulties.

Widyanty and Oktasari (2020) conducted a study that examined the influence of financial ratios such as BOPO (operational expanse/operational income), ROA (profit before tax/total asset), CAR (capital/asset with risk), LDR (loan to deposit ratio), NPL (non-performing loans), ROE (net profit/equity), and NIM (net interest/earning assets) in predicting the bankruptcy of 33 banks in Indonesia. For this, they applied logit regression to analyze the data collected from 33 banks in 2018 and found that only LDR had a significant but unexpected impact on bankruptcy prediction, and the other ratios were not significant but had the expected signs. It is also observed that the model achieved an accuracy of 94.7%, which is good, with a false negative rate of 12.50% and a false positive rate of 40% (Widyanty & Oktasari, 2020). In conclusion, they made some recommendations for future research to expand the time frame and to include other factors, such as the size and compliance of their studies.

Chatterjee (2018) conducted a comparative analysis of Altman's *Z*-score model with Ohlson's *O*-score model to examine their predictive value for financial distress among widely owned large-cap firms in India during 2000–2013. The results of the research show that while Ohlson's model is more accurate than Altman's in predicting bankruptcy, the latter is superior in judging overall financial health and solidity supported by statistically significant Pearson chi-square tests. This study highlights the unique advantages of each model and offers vital information on how to apply each to evaluate the soundness of banks (Chatterjee, 2018).

Chitta et al. (2019) examined the financial solidity of Maharatna Companies through the application of the Altman *Z*-score model. The study covered the years from 2014 to 2018 with the intention to investigate whether these leading public sector undertakings (PSUs) were in any financial trouble even after being self-sufficient in their entire past. It also disclosed that a few Maharatna organizations have had their earnings dropping, which resulted in the intervention by the government's finance department. However, this group exhibited different levels of economic performance that implied possible weaknesses among some firms. These findings are important as they shed light on how India's top PSUs work financially and underline the importance of constant monitoring and support required to keep them intact for national growth purposes (Chitta et al., 2019).

Theoretical Framework

Financial Distress

Financial difficulty occurs when a company is unable to pay its debts, which include operating expenses, authority requirements, and credit payback. This exerts an adverse effect on the company, its partners, and the economy as a whole. Many factors impact on financial distress of a firm, such as leverage, profitability, liquidity, firm size, and age. According to (Ikpesu et al., 2020), profitability and financial distress is negatively affected by the size of the firm, which means that the more profitable and larger the firm is less likely it will experience financial distress. However, in contrast, a financial crisis benefits from liquidity and leverage which means a company has a higher leverage ratio and less liquidity, it becomes more susceptible to facing financial distress. When talking about the age of the firm it has a negative effect on financial distress; it means older firms are more resilient and stable than younger firms. Still, it is also noticed that these factors are not independent of each other, and they interact in complex ways. Also, there are factors such as revenue growth, share price, perception and coping strategy that show the impact on the financial distress of a firm (Isayas & McMillan, 2021; Ikpesu, 2019; Perry & Morris, 2005). In order to prevent or overcome financial distress, the firms are required to adopt sustainable remedial measures that can deal with both internal and external factors, such as improving operational efficiency by reducing costs, restructuring debt, diversifying income sources, enhancing corporate governance and seeking external guidance (Ikpesu et al., 2020).

Altman Z-score model

Many people use the well-established and tried-and-true Altman *Z*-score technique when discussing potential financial problems (Hayes et al., 2010). As an accomplished multivariate technique that embraces numerous accounting ratios together with market-derived price data, this tool is able to calculate both a company's present financial soundness and its likelihood of going bankrupt in two years. This model was introduced by Edward Altman some 50 years ago, in 1968, and it still enjoys wide acceptance today. It is extensively used by practitioners, researchers and analysts for evaluating firms from different sectors of the economy across countries (Goh et al., 2022). The original Altman *Z*-score approach consists of five ratios, which were weighted using coefficients derived through discriminant analysis for 66 manufacturing companies. The following five metrics include sales/total assets ratio, EBIT/total assets ratio, working capital/current assets ratio, market value of equity/book value of liabilities ratio, and retained earnings/total assets ratio. The Altman *Z*-Score formula is as follows:

$$Z = 1.2A + 1.4B + 3.3C + 0.6D + 1.0E$$

Altman's (1968) study conducted an evaluation system called "*Z*-score," which has been implemented for identifying possible risks associated with companies filing bankruptcy cases in the future. The calculation involves using numerous financial ratios that assist us in deriving scores, which then reflect potential financial stability for the organizations under consideration. Post-evaluation results show that any company scoring under $Z = 1.81$ is put into the high-risk category; firms ranking between $Z = 1.81$ and $Z = 2.99$ fall into the moderate-risk category, and those ranking above $Z = 2.99$ can be identified as having a low possibility. The Altman *Z*-score approach has undergone numerous modifications and adjustments over time to accommodate various circumstances and uses. One example of this is the model's refinement for private enterprises (Altman et al., 1977); the substitution involved replacing the market value of the equity ratio with the book value of the equity ratio. An improved version of the model with a current liabilities to current assets ratio was produced in 1995, specifically for emerging markets (Altman et al., 1995). The new model by Altman et al. (2017) used only four ratios for non-manufacturing firms instead of the previous five. These include the ratios of book value of equity to total liabilities, working capital to total assets, retained earnings to total assets, earnings before interest and taxes, and depreciation and amortization to total assets (Altman et al., 2017).

Research Methodology

This study used a quantitative research design to anticipate the financial hardship of logistics companies listed on the NSE (India). The analysis was performed with a sample size of 41 firms, which is also the total logistic companies listed in NSE, using the Altman *Z*-score model. Distressed businesses were rated below 1.81 on the *Z*-scores, whereas those with a score above the mark were ranked as non-distressed. Using secondary data from these logistic companies' annual reports between 2019 and 2023, financial ratios were computed. These ratios include sales to total assets (SA/TAS), EBIT to total assets (EBIT/TAS), retained earnings to total assets (RTE/TAS), market value of equity to total liabilities (MVE/TLI), and working capital to total assets (WC/TAS). Finally, the resulting figures assisted in calculating the Altman *Z*-score for each company.

ANOVA and Pearson correlation matrix were two of the inferential statistics used, along with other descriptive and descriptive statistics, to determine the degree to which the financial ratios and Altman *Z*-score were associated. Additionally, through logistic regression analysis (coefficient analysis and Hosmer–Lemeshow test), it is examined whether or not these ratios can be used to predict an organization's risk of becoming financially distressed. By doing this, it is possible to determine which ratio had the greatest impact on forecasting

potential risks that could result in bankruptcy or insolvency. The program used to carry out the entire procedure was SPSS version 25.

Data Analysis and Results

Table 1 presents descriptive statistics for logistics companies registered on the NSE (India). The *Z*-score mean value of 6.8822 for these logistics companies indicates a minimal probability of financial difficulty, according to the statistics. The average WC/TAS for these companies is 0.131741, indicating that they have a comparatively lower WC/TAS ratio. With a mean value of 9.027395 for the MVE/TLI ratio, these logistics companies have a comparatively high market value of equity in relation to their total liabilities. The EBIT/TAS ratio has a mean value of 0.076402, suggesting that these businesses generate a moderate return on their assets. The SA/TAS ratio, which has a mean value of 1.565291, demonstrates that logistics organizations generate a sizable amount of revenue relative to their total assets.

Table 2 displays the association between Altman's *Z*-score model and financial ratios that are used for forecasting the financial distress of logistics companies listed on NSE (India). These ratios are as follows:

Table 1. *Altman's Z-Score Model-Based Descriptive Statistics of Financial Ratios for Logistics Companies Listed on the NSE (India)*

	Descriptive Values		
	Mean Value	Standard Deviation	*N*
Z-score	6.8822	24.35243	205
WC/TAS	0.131741	0.4611614	205
RTE/TAS	−0.313620	4.9917189	205
EBIT/TAS	0.076402	0.2506050	205
MVE/TLI	9.027395	50.6542571	205
SA/TAS	1.565291	1.2297695	205

Table 2. *Pearson Correlation Matrix of Financial Ratios for Logistics Companies Listed on the NSE(India) Used in the Altman Z-Score model*

		Z-Score	WC/TAS	RTE/TAS	EBIT/TAS	MVE/TLI	SA/TAS
Pearson	*Z*-Score	1.000					
Correlation	WC/TAS	0.197	1.000				
	RTE/TAS	−0.858	0.025	1.000			
	EBIT/TAS	−0.024	0.760	0.292	1.000		
	MVE/TLI	0.988	0.103	−0.921	−0.133	1.000	
	SA/TAS	0.179	0.308	−0.127	0.229	0.120	1.000
Sig. (1-tailed)	*Z*-Score						
	WC/TAS	0.002					
	RTE/TAS	0.000	0.360				
	EBIT/TAS	0.366	0.000	0.000			
	MVE/TLI	0.000	0.071	0.000	0.029		
	SA/TAS	0.005	0.000	0.035	0.000	0.043	

Z-score, EBIT/TAS ratio, WC/TAS ratio, MVE/TLI ratio, and SA/TAS ratio. After closely examining the table, the most important finding is that there is a substantial link between these two statistics, as seen by the highest Pearson's correlation coefficient of 0.988 between the *Z*-score and MVE/TLI ratio. This observation shows that there is a positive influence between them, indicating that companies that have higher market values of equity compared to their total liabilities may have lower chances for financial distress. On the other hand, one important thing, in this case, is the negative correlation found across these indicators in relation to the *Z*-score, which included RTE/TAS (–0.858) and EBIT/TAS (–0.024). This means that if any firm has low values for either or both of these variables, it may be at risk of insolvency.

The correlation between the *Z*-score and WC/TAS (0.197) and SA/TAS (0.179) was highly positive, indicating that more working capital as well as sales ratios are linked to lower levels of financial distress. A significant *p*-value ($p < 0.05$) correlation matrix shows the statistical significance of relationships between financial ratios and the *Z*-score. It is important to note that the financial ratios of logistic companies listed on the NSE (India) can be assessed with success by using Altman's *Z*-score model. It is possible to forecast future financial difficulties by using this technique.

The factors employed in the equation to predict financial hardship are displayed in Table 3, together with the estimates of the coefficients, standard errors, Wald statistics, degrees of freedom, and pertinent significance values. Table 3 also includes the exponential of each coefficient (Exp(B)) and the related 95% confidence intervals. With *p*-values of 0.001 or below, the findings indicate that the MVE/TLI, RTE/TAS, and SA/TAS are significant predictors of financial distress. Conversely, with *p*-values of 0.560 and 0.003, respectively, WC/TAS and EBIT/TAS do not appear to be significant predictors. The table provides important information regarding the financial ratios that hold significance in foreseeing the financial distress of logistics firms enlisted in the NSE of India with the aid of Altman's *Z*-score model.

Table 4 shows the ANOVA results of the regression model, with *Z*-score as a dependent variable and five

Table 3. *Variables in the Equation for Altman's Z-score Model in Forecasting Financial Distress among Logistics Companies Listed in NSE (India)*

		B	SE	Wald	*df*	Sign.	Expe(B)	95% C.I for EXP(B)	
								Lower	Upper
Step 1*	WC/TAS	2.270	3.896	0.340	1	0.560	9.681	0.005	20,050.50
	RTE/TAS	15.926	4.861	10.732	1	0.001	8248.68	600.445	11,332.77
	EBIT/TAS	–18.616	6.314	8.693	1	0.003	0.000	0.000	0.002
	MVE/TLI	2.048	0.640	10.237	1	0.001	7.756	2.211	27.204
	SA/TAS	6.916	1.563	19.582	1	0.000	1,008.095	47.119	21,567.907
	Constant	–8.712	2.378	13.426	1	0.000	0.000		

Note. *Variable(s) entered on step 1: WC/TAS, RTE/TAS, EBIT/TAS, MVE/TLI, and SA/TAS.

Table 4. *ANOVA Results for the Altman's Z-Score [a] Model and Regression Analysis to Forecast Financial Distress of Logistics Companies Listed in NSE (India)*

	Model	Total of Squares	*df*	Mean Square Value	*F*	Sig.
1	Regression	120,887.470	5	24,177.494	51,823.819	.000[b]
	Residual	92.840	199	0.467		
	Total	120,980.310	204			

Note. ** [a.] Dependent Variable: *Z*-score.

[b.] Predictors: (Constant), WC/TAS, RTE/TAS, EBIT/TAS, MVE/TLI, SA/TAS.

independent variables (RTE/TAS, MVE/TLI, EBIT/TAS, WC/TAS, and SA/TAS) are predictor variables, shows that substantial portion of the change in the dependent variable is accounted due to predictor variables ($F(5,199) = 51,823.819$, $p < 0.001$). The sum of squares for regression significantly surpasses the sum of squares for residuals (120,887.470 versus 92.840), indicating a good model fit with important predictors; furthermore, the mean square for regression is also much larger than that for residuals (24,177.494 versus 0.467), indicating that the predictor variables make a substantial contribution to the variance observed in the dependent variable, supporting the conclusion that is made that the five independent variables are significant predictors of Z-score, yet requiring additional investigation to find out the specific contribution of each independent variable to the predictive power of the model.

Table 5 displays Altman's Z-score model's coefficients and its predictive power for financial hardship in logistics companies that are listed on the NSE (India). The MVE/TLI ratio and the RTE/TAS ratio are the most significant predictors of financial distress, with the former having a high standardized coefficient of 1.255 and the latter having a standardized coefficient of 0.296. However, although having somewhat lower standardized coefficients (0.026, 0.024, and 0.052, respectively), the WC/TAS, EBIT/TAS, and SA/TAS ratios still offer valuable information for predicting financial trouble. Our collinearity statistics, which show that there is no multicollinearity problem in our model because of the above tolerance values, corroborate the statistical significance of the t-values for each independent variable as Z-score predictors with respect to a p-value of 0.05.01 and a VIF of less than 10.

Table 6 presents the results of the stepwise logistic regression analysis for predicting financial hardship in logistics companies listed on the NSE (India). The results indicate that the model's Cox & Snell R-square value is 0.563, and the -2 Log likelihood is 32.445. After analyzing the data, we discovered that the Cox and Snell R-square provides insightful information. Specifically, we discovered that our selected model can explain 56.3% of the variation in our dependent variable. The 0.898 Nagelkerke R-square value provides a further indication of a

Table 5. *Coefficients[a] of the Altman's Z-Score Model for Predicting Financial Distress of Logistics Companies Listed in NSE (India)*

Model		Unstandardised Co-efficient		Standardised Co-efficient	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	–0.092	0.080		–1.158	0.248	–0.249	0.065		
	WC/TAS	1.387	0.171	0.026	8.12	0.000	1.050	1.724	0.369	2.713
	RTE/TAS	1.445	0.028	0.296	51.94	0.000	1.390	1.499	0.119	8.426
	EBIT/TAS	2.342	0.330	0.024	7.088	0.000	1.690	2.993	0.334	2.998
	MVE/TLI	0.603	0.003	1.255	229.76	0.000	0.598	0.608	0.129	7.733
	SA/TAS	1.035	0.042	0.052	24.858	0.000	0.953	1.117	0.872	1.147

Note. [a] Dependent variable: Z-score.

Table 6. *Model Summary : Financial Ratio Analysis for Predicting Financial Distress Among Logistics Firms Listed on NSE using the Altman Z-Score Model*

Step	-2 Log likelihood	Cox and Snell R-square	Nagelkerke R-square
1	32.445[a]	0.563	0.898

Note. [a] Estimation was halted at iteration 12 because parameter estimations changed by less than .001.

Table 7. *Hosmer–Lemeshow Test Results : Financial Ratio Analysis for Predicting Financial Distress Among Logistics Companies Listed on NSE using Altman Z-Score Model*

Step	Chi-square	*df*	Sig.
1	0.874	8	0.999

Table 8. *Contingency Table : Hosmer-Lemeshow Test : Financial Ratio Analysis for Predicting Financial Distress Among NSE-Listed Logistics Companies Using Altman's Z-Score Model*

		Financial Condition = Financial Distress		Financial Condition = Non Distress		Total
		Observed	Expected	Observed	Expected	
Step 1	1	21	20.953	0	0.047	21
	2	16	16.659	5	4.341	21
	3	3	2.109	18	18.891	21
	4	0	0.229	21	20.771	21
	5	0	0.046	21	20.954	21
	6	0	0.004	21	20.996	21
	7	0	0.000	21	21.000	21
	8	0	0.000	21	21.000	21
	9	0	0.000	19	19.000	19
	10	0	0.000	18	18.000	18

strong match after analyzing the number of iterations. It became apparent that the estimation progress terminated when it reached its 12th iteration because there was a negligible alteration in parameter estimates by less than 0.001; as such, it confirms with conviction that this model has achieved reliability and stability. Thus, it can be said that the model accurately forecasts financial distress in logistics companies that are listed on the NSE.

About evaluating a logistic regression model's ability to predict financial difficulties. Table 7 displays the statistical analysis of the Hosmer and Lemeshow goodness of fit test. This test evaluates how well binary outcome variables fit into the model. In this study, the logistic regression model used is a good fit for predicting financial distress among logistics companies listed on the NSE of India, as indicated by the Hosmer and Lemeshow test results, which show a chi-square value of 0.874 with eight degrees of freedom and a significance level of 0.999, which is considered to be a non-significant *p*-value which has to be greater than 0.05.

Table 8 presents the contingency table of Hosmer and Lemeshow, which shows observed and expected frequencies for two levels of the financial condition, i.e., financial and non-distressed, at each step of analysis from steps 1 to 10, along with expected frequencies that are calculated based on the logistic regression model, whereas observed frequencies represent actual values from the dataset. The logistic regression model employed in this study fits the data well because the expected and observed frequencies across all steps are reasonably similar. This suggests that the model's predicted probabilities of financial distress are consistent with the dataset's actual financial distress occurrences.

Using Altman's *Z*-score model to forecast financial hardship, Table 9 shows the observed and anticipated financial circumstances of logistics companies listed on the NSE of India. The financial distress and non-distress categories are created by the model using the financial ratios to classify organizations. The model categorization is displayed by the predicted values in Table 9, while the observed values indicate the actual financial status of the companies. It can be observed that Altman's *Z*-score model performs very well in forecasting financial distress among logistics companies, with 198 out of 205 observations correctly classified, with an overall 96.6%

Table 9. *Accuracy of Financial Ratio Analysis for Predicting Financial Distress Among NSE-Listed Logistics Companies Using the Altman's Z-Score Model*

Observed			Predicted		
			Financial Condition		Percentage Correct
			Financial Distress	Non Distress	
Step 1	Financial Condition	Financial Distress	36	4	90.0
		Non Distress	3	162	98.2
	Overall Percentage				96.6

Note. * The cut value is 0.500.

accuracy. Also, the model identifies 36 out of 40 financially distressed companies as distressed, with 90.0% accuracy, and 162 out of 165 non-distressed companies as non-distressed, showing 98.2% accuracy.

Findings

↳ Logistics firms on the NSE in India show low bankruptcy risk with a high average *Z*-score of 6.8822.

↳ These companies exhibit relatively low working capital ratios and negative retained earnings as proportions of total assets.

↳ The EBIT/total assets ratio suggests that there is a moderate average return on assets.

↳ The high market value of the equity/total liabilities ratio shows a strong equity base.

↳ The sales/total assets ratio reflects average sales levels.

Correlation Matrix Evaluation

↳ A positive correlation exists between the market value of equity/total liabilities ratio and the *Z*-score (0.988).

↳ Negative associations for retained earnings/total assets & EBIT/total assets indicate that reduced financial distress risks are associated with higher ratios for these measures.

↳ *Z*-scores have positive links to working capital/total assets and sales/total assets due to the fact that they may help mitigate financial distress risks.

Financial Distress Predictors

↳ Retained earnings/total assets, market value of equity/total liabilities, and sales/total assets significantly predict financial distress at $p \leq .001$ level.

↳ The ability to predict financial distress is not significant for working capital/total assets ($p = 0.560$).

↳ EBIT/total assets have less negative significance, but they still reflect financial health.

Model Robustness

↳ These five ratios have been proven to be statistically significant predictors for *Z*-score, as indicated by the high *F*-value and low *p*-value in the ANOVA.

↳ The model was able to adequately capture most of the data variance in the *Z*-score.

Importance of Predictors

✤ The two most critical ratios that are useful in the forecasting of financial distress are the market value of equity/total liabilities and retained earnings/total assets.

✤ All variables are statistically significant ($p < 0.05$) without multicollinearity issues.

Altman's Z-score Model Effectiveness

✤ About 56.3% of the variation in financial distress (Cox and Snell R-square) is explained by Altman's Z-score model, which fits well with the data.

✤ The prediction accuracy rate of this model stands at 96.6%.

✤ At NSE in India, comprehensive tests show that Altman's Z-score model is effective for predicting financial distress in logistics firms.

Conclusion

To conclude, this study reviews the financial ratios of logistics companies listed at NSE in India and estimates the probability of going bankrupt by using the Altman Z-score model. The mean Z-score value of 6.8822 reported in this study indicates that the transportation/ logistics industry in India has a low risk of financial distress. Despite all these facts, this area has various problems like lack of working capital and negative retained earnings-to-total assets ratio amid fierce competition, but it was found out that market value equity to total liabilities ratio and retained earnings to total assets are significant predictors for bankruptcy prediction. Additionally, Altman's Z-score model proves it fits well with the data as indicated by a high Cox and Snell R-square figure suggesting that it explains 56.3% variation of a dependent variable, i.e., Z-score value. The model of the Altman Z-score is also dependable and trustworthy in forecasting the bankruptcy of logistic companies with a total accuracy rate of 96.6%. It contributes to the existing literature on financial risk management in Indian logistics, giving investors, financial analysts, and policymakers essential ideas. For instance, a study similar to this one can be conducted across other sectors and then differing industries compared or alternative research can be carried out whereby the Altman's Z-score model is contrasted to other models to predict future insolvency for India's logistics industry as well as other sectors.

Authors' Contribution

G. Thouseef Ahamed provided the idea for the empirical investigation. He also designed a quantitative study, extracted credible research papers, organized them using keywords, and identified the research gap. T Md. Inthiyaz Ahammed supervised the work, who also verified the analytical procedures and used SPSS to evaluate the data.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or material discussed in this manuscript.

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