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Financial disrtress predicton through Z-Atman's Model – A case study in select manufacturing firms in India

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Abstract
Financial distress is considered as one of the major concerns in corporate sector due to continuous increase in filling of bankruptcy by the many companies in India due to various reasons. In this context, prediction of financial distress of the companies well in advance gains significance by the decision makers. Therefore, present study adopted Atman's Z-score model in prediction of financial distress in four already failure companies in India. The companies included Gensol, LMT, Sintex and Galva Steel limited. The result of the study strongly evidence that, Z-score model effectively predicted the bankruptcy of the selected companies in before three years also. The Z-score of all selected companies in three years reported less than 1.8 which is considered as financial distress zone under the model. Besides, the study also found that poor working capital management, deterioration in retained earnings and profitability of the firms are major factors pushed the companies towards bankruptcy in India.

Keywords: Financial distress, bankruptcy, Atman's Z model, Z-score model, Insolvency

Introduction

Financial soundness of the company plays significant role in dynamic decision-making process by the various stakeholders. Financial soundness strongly and significantly affects the operations of every company. They apply various traditional and modern tools to analyze the financial wellbeing of the company timely and review of their decision as per the outcome of the tools (Farhaan *et al* 2023). If they found improvement in financial soundness they will take favorable decisions else they many review their present position. In this context, reliability and validity of the traditional and modern tools in prediction of financial soundness leads to wise financial and investment decision by the stakeholders. On the other hand, distress in financial position refers to a situation where liabilities exceed assets and causes the survival problem to the firm. Financial distress of the firm may cause by the various factors such as business losses, large debts, tight regulatory framework, unhealthy competition, fall in demand for products, unexpected crisis in the country and society etc. The inefficiency of the firm in effective management of these situation may leads to survival issues and even leads to liquidation of the firm, Ikpesu, Fredrick (2019) [9].

The measurement of the financial distress can be done through traditional methods like financial ratios and advanced methods like Neural network technologies. However, in prediction of financial distress Z-Atman's is widely applied and accepted models by the academicians, researchers and analysts across the countries. Therefore, present study emphasized on the application of Z-Atman's model (1968) [2] in prediction of financial distress or bankruptcy position of the four selected manufacturing companies across the different industries in India.

Review of Lietrature

The original study of Edward Atman's (1968) [2] found 94 percentage of accuracy of the model in prediction of bankruptcy one year before. Chung *et al* (2008) [8] study outcome stressed that z-atman's model is an effective one in prediction of bankruptcy of a company one year advanced. Simialrly, Salimi study (2015) [15] supported that Z-score is effective in prediction of bankruptcy one year before with 92.50 percent accuracy. Chatterjee (2018) [7] study confirmed that Z-atman's model is very superior in prediction of bankruptcy and financial wellbeing as compared to many model. Joshi (2020) [10] study on Indian public sector banks financial soundness revealed Z-atman's model is very reliable and accurate metric in predicting the financial turmoil. Similarly, Mohammad Asif (2024) [12] analyzed the Z-score of 10 listed companies in BSE scope for bankruptcy and revealed that z-score model is sophisticated technique for prediction of listed companies in Indian stock market well in advance. The study also universally applied by across the industries and countries by academicians and researchers and witnessed mixed result such as Barreda, Albert (2017) [5] applied in hospital industry in United States and clearly observed positive result of the Z-score in prediction of bankruptcy. Zhang and Zhang (2016) [17] selected 629 bank holding companies in the U.S., to determine the impact of factors on the financial distress, with regard to the recent financial crisis. The study evidence that housing price index (HPI) and regulatory capital requirements were positively related to the Z-Score measure.

Similarly, Ying Wang & Michel Campbell (2010) [16] applied three Z-score models (original, restimated and revised) on publicly listed companies in China and found positive result that, Revised Z-score model was highest predicative accuracy among three models one year in advance. Chadha, P. (2016) [6] applied model on the listed companies of Kuwait and revealed that Z-Score model was significantly effective in prediction of distinction between financially stable and financially distressed companies. Kiaupaite-Grushniene (2016) [11] applied this model in agricultural sector of in Lithuanian and found that Z-score model is highly accurate in prediction of bankruptcy even in agriculture sector which is highly exposed to external factors such as weather conditions. Arun *et al* (2024)

examined Z-atman's model on the Tata group of institutions and strongly supported the model efficiency in prediction of bankruptcy in group of industries. Celli (2015) applied the model on 102 companies listed in Italian stock exchange and bankrupted later on during 1995-2013. Their findings clearly opined that Z-Atman's is highly applicable in prediction bankruptcy in Italian companies. Similarly, Alkhatib & Al Bzour (2011) [1] examined the model on the Jordanian listed companies and revealed that, Z- score is highly successful in prediction of bankruptcy of their companies in the country.

Z-Atman's Model

In this context, measuring of financial distress through financial elements simplified by the Edward Atman's in 1968 [2]. The outcome of this model is popular by Z-score which is result of integration of key financial metrics such as working capital, retained earnings, equity market value, EBIT, and sales Altman, E.I (1983) [3]. The five variables used to measure five aspects such as liquidity, profitability, leverage, solvency and activity, This model measures the financial distress or bankruptcy is measured beyond normal metric of profitability and liquidity (Altman, 1968) [2]. Since ever, this model was refined and improved its reliability and accuracy as Z-score model and widely using by academicians, research analysts and corporate entities in analyzing the financial distress or bankruptcy prediction. In the present study we used the Z-score of Edward Atman's revised model in 2014 (Atman *et al* 2014).

(Z Score= {(1.2×X1) + (1.4× X2) + (3.3× X3) + (0.6× X4) + (1.0× X5)})

X_1 - Ratio of net working capital to its total value of assets.

X_2 - Ratio of retained profits to its total value of assets.

X_3 - Ratio of earnings before interest and taxes (EBIT) to its total assets.

X_4 - Ratio of Market value of equity to the book value of its total liabilities.

X_5 - Ratio of total sales to its total value of assets.

Table 1: Z-Score model prediction Scale

Z score	Indication
1.8 and less	Severe financial distress and change for bankruptcy immediately
Between 1.8-2.7	Alarming situation and change for bankruptcy in two years
Between 2.7 to 2.99	Caution period need to take reforms
3 and above	Financially healthy and sound

Descripton of Research Variables

In these formulae X_1 Ratio indicates ability of the firms to meet its short term or immediate financial obligations through measuring the proportion of the current assets in total assets. Increase in this ratio indicates ensures higher liquidity and downwards indicates drop in liquidity and inability to meet short term financial obligations. The second ratio X_2 shows proportion of retained earnings/losses in total assets. High and increasing in the ratio indicates high profits of the company and large rely on internal funds for capital expenditure, on the contrary, decrease in the ratio indicates more rely on external funds (borrowings) for capital expenditure. The third ratio X_3 indicates company's ability to generate profitability from its business operations. The fourth variable X_4 indicates market of equity in relation to book value of its total liabilities. This helps in analyzing the how would market value of the company declined before declaration of bankruptcy, uptrend in the ration indicates high investors' confidence and down trend indicates low confidence of the investors on financial strength of the company. Finally, the fifth ratio X_5 measures the management efficiency in utilization of assets in revenue generation. In the present study, as per the model values of five ratios are calculated, presented and analyzed in data analysis and interpretation section.

Research Methodology

1. **Research Problem:** Prediction of financial distress in one of major topics in risk management practices. Besides, it is complex aspect in the finance and investment domains because distress is caused by the wide variety of expected reasons. These reasons included internal or external and controllable and un-controllable factors. In this regard, prediction of financial distress with high accuracy and reliability gain significance from the point of financial and investment decisions by the stakeholders. Z-Atman's proposed an unique model of to predict the financial distress through using financial variables of the company first in 1968 [2] which was revised sub-sequent and finally evolved as Z-score model and got wide acceptance by various academicians and researchers. It review of literature observed that, Z-score was applied on sector basis and country basis, compared with various other models. However, study found inadequate research and need for more research on the application of the model in emerging countries like India. The present study fulfills this research gap.

2. **Objective of the Study:** The present study aims to measure the accuracy and reliability of Z-Atman's Model in prediction of financial distress of four selected manufacturing companies in India.

3. **Sample Size and Period of Study:** In the present study four companies belongs to different industries are selected. These companies filed bankruptcy petition at National Company Law Tribunal (NCLT) in different years. These companies included Gensol engineering limited, LMT limited, Sintex industries limited and Galva Steel limited. The Z-score for these companies calculated before three years they filed petition at NCLT. These period included Gensol for period between 2022-24, LMT period 2015-2017, Sintex industries 2019-2021 and Galva steel company period is 2020-2022

4. **Research Design:** The present study is an analytical, applied and empirical research in nature and model examination of prediction of bankruptcy or financial distress of corporate sector in the economy. The selected prediction model is Z-Atman's bankruptcy model proposed in 1968 [2] which is widely accepted and applied by the academicians and researchers across

the countries in the world. The selected four companies included Gensol, LMT, Sintex and Galva Steel company. As per the model five ratios are considered as proportion of working capital, retained earnings, EBIT, Market value of equity and sales in relation to total assets/liabilities. In the study ratios are individual ratios are calculated and incorporated in the formulae and presented every year Z-score. Thus, statistical techniques used in the study are financial ratios. The data is collected from secondary data published in the annual reports of the selected companies in their respective period.

Data Anlysis and Interpration

Table 2: Z-Score Calculation of Gensol Engineering Ltd

	Year 2023-24	Numerator (Rs. Cr)	TA / TL (Rs. Cr)	Ratios (x)	1.2X1+1.4X2+3.3 X3+0.6X4+1.0X5	Z Score
			2023-24			
A	Working Capital/TA	286.94	2027.61	0.14	0.17	
B	Retained Earnings/TA	306.23	2027.61	0.15	0.21	
C	EBIT/TA	208.62	2027.61	0.10	0.34	1.20
D	MV of Equity/TL	37.87	2027.61	0.02	0.01	
E	Sales/TA	944.41	2027.61	0.47	0.47	
			2022-23			
A	Working Capital/TA	308.64	955.69	0.32	0.39	
B	Retained Earnings/TA	193.57	955.69	0.20	0.28	1.25
C	EBIT/TA	51.28	955.69	0.05	0.18	
D	MV of Equity/TL	12.22	955.69	0.01	0.01	
E	Sales/TA	373.14	955.69	0.39	0.39	
			2021-22			
A	Working Capital/TA	66.2	199.96	0.33	0.40	
B	Retained Earnings/TA	34.85	199.96	0.17	0.24	
C	EBIT/TA	19.04	199.96	0.10	0.31	1.76
D	MV of Equity/TL	10.94	199.96	0.05	0.03	
E	Sales/TA	155.85	199.96	0.78	0.78	

Source: Computed by the Author

Table 3: Z-Score Calculation of LMT

	RATIOS	Numerator (Rs Cr)	TA/ TL (Rs Cr)	Ratios (x)	1.2X1+1.4X2+3.3 X3+0.6X4+1.0X5	Z- Score
			2016-17			
A	Working Capital/TA	-783.48	135.79	-5.77	-6.92	
B	Retained Earnings/TA	-954.4	135.79	-7.03	-9.84	
C	EBIT/TA	-38.32	135.79	-0.28	-0.93	-16.87
D	MV of Equity/TL	81.98	135.79	0.60	0.36	
E	Sales/TA	61.83	135.79	0.46	0.46	
			2015-16			
A	Working Capital/TA	-701.32	181.62	-3.86	-4.63	
B	Retained Earnings/TA	-863.71	181.62	-4.76	-6.66	
C	EBIT/TA	-30.73	181.62	-0.17	-0.56	-10.71
D	MV of Equity/TL	81.98	181.62	0.45	0.27	
E	Sales/TA	157.79	181.62	0.87	0.87	
			2014-15			
A	Working Capital/TA	-632.69	203.9	-3.10	-3.72	
B	Retained Earnings/TA	-785.35	203.9	-3.85	-5.39	
C	EBIT/TA	-37.94	203.9	-0.19	-0.61	-8.46
D	MV of Equity/TL	81.98	203.9	0.40	0.24	
E	Sales/TA	207.33	203.9	1.02	1.02	

Source: Computed by the Author

Table 4: Z-Score Calculation of Sintex Industries Limited

	RATIOS	Numerator (Rs Cr)	TA/ TL (Rs Cr)	Ratios (x)	1.2X1+1.4X2+3.3 X3+0.6X4+1.0X5	Z score
			2020-21			
A	Working Capital/TA	-6922.08	9,860.04	-0.70	-0.84	
B	Retained Earnings/TA	1,814.48	9,860.04	0.18	0.26	
C	EBIT/TA	244.74	9,860.04	0.02	0.08	
D	MV of Equity/TL	59.92	9,860.04	0.01	0.00	-0.32
E	Sales/TA	1,744.16	9,860.04	0.18	0.18	
			2019-20			
A	Working Capital/TA	-6418.16	10,557.93	-0.61	-0.73	
B	Retained Earnings/TA	3,070.11	10,557.93	0.29	0.41	
C	EBIT/TA	-507.05	10,557.93	-0.05	-0.16	
D	MV of Equity/TL	59.41	10,557.93	0.01	0.00	-0.32
E	Sales/TA	1,662.43	10,557.93	0.16	0.16	

2018-19						
A	Working Capital/TA	-703.41	11,453.16	-0.06	-0.07	
B	Retained Earnings/TA	4,322.28	11,453.16	0.38	0.53	
C	EBIT/TA	-592.64	11,453.16	-0.05	-0.17	0.54
D	MV of Equity/TL	59.41	11,453.16	0.01	0.00	
E	Sales/TA	2912.32	11453.16	0.25	0.25	

Source: Computed by the Author

Table 5: Z-Score Calculation of Uttam Galva Steels

	Ratios	**Numerator (Rs Cr)**	**TA/ TL (Rs Cr)**	**Ratios (x)**	**1.2X1+1.4X2+3.3 X3+0.6X4+1.0X5**	**Avg**
2021-22						
A	Working Capital/TA	-7234.03	5,765.93	-1.25	-1.51	
B	Retained Earnings/TA	-4,338.37	5,765.93	-0.75	-1.05	
C	EBIT/TA	-289.39	5,765.93	-0.05	-0.17	-2.57
D	MV of Equity/TL	142.26	5,765.93	0.02	0.01	
E	Sales/TA	854.1	5,765.93	0.15	0.15	
2020-21						
A	Working Capital/TA	-7219.45	6,013.75	-1.20	-1.44	
B	Retained Earnings/TA	-4,042.20	6,013.75	-0.67	-0.94	
C	EBIT/TA	-261.47	6,013.75	-0.04	-0.14	-2.4
D	MV of Equity/TL	142.26	6,013.75	0.02	0.01	
E	Sales/TA	663.13	6,013.75	0.11	0.11	
2019-20						
A	Working Capital/TA	-590.13	6,285.44	-0.09	-0.11	
B	Retained Earnings/TA	-3,816.72	6,285.44	-0.61	-0.85	
C	EBIT/TA	-1010.05	6,285.44	-0.16	-0.53	-1.4
D	MV of Equity/TL	142.26	6285.44	0.02	0.01	
E	Sales/TA	523.17	6285.44	0.08	0.08	

Source: Computed by the Author

Table 6: Z-Atman's Model Predication Performance In Selected Companies

	Year wise Z-score			**Z-Atman's Model**
Company	**I**	**II**	**III**	
Gensol Engineering	1.76	1.25	1.20	
ZONE	Distress	Distress	Distress	Successful
LMT Company	-8.46	-10.73	-16.87	
ZONE	Distress	Distress	Distress	Successful
Sintex Industries Limited	0.54	-0.32	-0.32	
ZONE	Distress	Distress	Distress	Successful
Uttam Galva Steels	-1.4	-2.4	-2.57	
ZONE	Distress	Distress	Distress	Successful

Source: Compiled by the Author

Discussion on Overall Result

Table 02 exhibits the calculation of Z-score of the Gensol engineering company for the three years period i.e. 2022-2024 [12]. As per the Z-score formulae, In 2022 working capital to Total assets ratio was 0.40, Retained earnings to total assets ratio was 0.24, EBIT to TA ratio was 0.31, MV of equity to total liabilities ratio was 0.03 and finally sales to TA ratio was 0.78. The average Z-score ratio in this ratio was 1.20. Similarly, In 2023 working capital to Total assets ratio was 0.39, Retained earnings to total assets ratio was 0.28, EBIT to TA ratio was 0.18, MV of equity to total liabilities ratio was 0.01 and finally sales to TA ratio was 0.39. The average Z-score ratio in this ratio was 1.25. Similarly, In 2024 working capital to Total assets ratio was 0.17, Retained earnings to total assets ratio was 0.21, EBIT to TA ratio was 0.34, MV of equity to total liabilities ratio was 0.01 and finally sales to TA ratio was 0.47. The average Z-score ratio in this ratio was 1.76.

Table 03 revealed the calculation of Z-score of the LMT for the three years period i.e 2015-2017. As per the Z-score formulae, In 2015 working capital to Total assets ratio was negative with -3.72, Retained earnings to total assets ratio was also negative with -5.39, EBIT to TA ratio was also negative with -0.61, MV of equity to total liabilities ratio was 0.24 and finally sales to TA ratio was 1.02. Consequently, Z-score ratio was also negative -16.87. Similarly, In 2016 working capital to Total assets ratio was negative with -4.63, Retained earnings to total assets ratio was also negative with -6.66, EBIT to TA ratio was also negative with -0.56, MV of equity to total liabilities ratio was 0.45 and finally sales to TA ratio was 0.87. As result, Z-score ratio was also negative with -10.71. In the final year also, 2016-17 working capital to Total assets ratio, Retained earnings to total assets ratio and EBIT to TA ratio were negative as -5.77, -7.03 and -0.28 respectively. MV of equity to total liabilities ratio was 0.60 and finally sales to TA ratio was 0.46. The Z-score ratio in this ratio was -8.46 which is worse than previous years.

Table 04 evidence for the calculation of Z-score of the Sintex industries for the three years period i.e 2019-21-. As per the Z-score formulae, In 2019 working capital to Total assets ratio was negative with -0.07 EBIT to TA ratio was also negative with -0.17, Retained earnings to total assets ratio was 0.38, MV of equity to total liabilities ratio was

0.01 and finally sales to TA ratio was 0.25. Consequently, Z-score ratio was -0.32. In second year of the study, In 2019-20 working capital to Total assets ratio further worsen to negative with –0.73, EBIT to TA ratio was also negative with -0.05. Retained earnings to total assets ratio was 0.29, MV of equity to total liabilities ratio remains stable at 0.01 and finally sales to TA ratio was drop to 0.16. As result, Z-score ratio was turned into negative of --0.32. In the final year also, 2020-21 working capital to Total assets ratio further worsen to negative with –0.84, EBIT to TA ratio was 0.02. Retained earnings to total assets ratio was 0.18, MV of equity to total liabilities ratio remains stable at 0.01 and finally sales to TA ratio was drop to 0.18. The Z-score ratio in this ratio was 0.54.

Table 05 shows the calculation of Z-score of the Uttam galva steel for the three years period i.e 2020-22. As per the Z-score formulae, In 2020 working capital to Total assets ratio was negative with -0.11, Retained earnings to total assets ratio was also negative with -0.85, EBIT to TA ratio was also negative with –0.53, MV of equity to total liabilities ratio was 0.01 and finally sales to TA ratio was 0.08. Consequently, Z-score ratio was also negative -1.4. Similarly, In 2020-21 working capital to Total assets ratio was negative with -1.44, Retained earnings to total assets ratio was also negative with –0.94, EBIT to TA ratio was also negative with -0.14, MV of equity to total liabilities ratio was 0.01 and finally sales to TA ratio was 00.11 As result, Z-score ratio was also negative with -2.4. In the final year also, 2021-22 working capital to Total assets ratio, retained earnings to total assets ratio and EBIT to TA ratio were negative as -1.51, -1.05 and -0.17 respectively. MV of equity to total liabilities ratio was 0.02 and finally sales to TA ratio was 0.11. The Z-score ratio in this ratio was -2.57 which is most worst than previous years.

The above (06) table clearly shows that Z-score model of four selected manufacturing companies' years wise and overall Z-score and its successful rate in prediction. The z-score found that selected four companies have reported distress zone in all three years (with lower value of 1.80) which means that, z-score model can predict the financial distress well in advanced than other models with high accuracy.

It is revealed from the study that, among five research variable analyzed for bankruptcy prediction in selected company in India, poor working capital management is first and highly significant factor causing for financial distress in four companies where X_1 Ratio reported deterioration gradually and even negative ratio too. Thereafter, down trend and negative values (losses) of X_2 retained earnings (accumulated losses) and X_3 EBIT (losses) are another two major factors of financial distress in selected four companies. The rest of two factors such as revenue and market value reported mixed result but has no significant impact on the Z-score. Therefore, the study found that, among all research variables inefficiency in working capital, unprofitability in business operations (EBIT) and accumulated losses (retained earnings) are major pushing factors for bankruptcy in selected companies.

Conclusion

Through this study once again proved that, Atman's Z-score model is highly accurate and reliable in prediction of financial distress of companies well in advance. In the study, sample size consists of four companies which already reported bankruptcy in India through filing a petition at NCLT. The study observed that, in selected five research variables all variables reported deterioration during the study period which result in poor Z-score (less than 1.8) i.e. distress zone in all three years of four companies. This indicates that, Atman's Z-score model is highly accurate and reliable in prediction of bankruptcy and financial distress across the industries in emerging countries like India. The outcome of the present study is very useful to the investors and other stakeholder to take financial and investment decisions.

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