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Comparative Analysis of Financial Health of Selected Indian Metals and Mining Companies Using the Altman Z-Score, And Zmijewski Models

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Abstract
The mining and metals industry holds significant importance in the global economy and is crucial for India's economic growth. This study delves into the financial stability of Indian Metals and Mining Companies using two prominent insolvency prediction models: Altman's Z-Score and Zimjewski's X-Score. The research period spans three years from 2019-20 to 2021-22. Data analysis employs both quantitative and qualitative research methods with descriptive statistics and various tests, relying on secondary data sources from credible institutions like the Money Market and Capitaline. The study's sample size includes ten Indian Metals and Mining Companies, evaluating their financial health and bankruptcy risk. Altman's Z-Score, a metric incorporating multiple financial ratios, indicates the likelihood of bankruptcy for manufacturing industries. Meanwhile, Zimjewski's X-Score model forecasts bankruptcy within two years using net income to total assets ratio, total debt to total assets ratio, and current assets to current debt ratio. The results demonstrate a range of financial stability scores among the selected companies, with some exhibiting consistently low bankruptcy risks, while others show fluctuations. The study's findings emphasize the importance of financial analysis in assessing the stability of companies in the metals and mining sector. The research contributes valuable insights for investors, creditors, and financial analysts, aiding informed decision-making processes and promoting economic stability within the industry. The study uses secondary data sources but faces issues like data availability and potential mistakes. The sample size is small, with only ten Indian Metals and Mining Companies. To improve data accuracy, researchers should cross-reference data, confirm it with financial reports, and expand the sample size. The findings can help investors, creditors, and legislators make informed decisions.

Keywords: Altman Z-Score, Zmijewski Models, Metals and Mining, Financial Ratios, Descriptive Statistics

1. Introduction

The mining and metals industry is vital to the world economy because it provides raw materials needed by many other businesses (Filippou, D., & King, M. G. 2011). The ability of businesses in this industry to maintain operations, make investments, and withstand changes in the economy is directly impacted by their financial stability (Lee, K. H. 2017). In India's view, an important source of employment and industrial growth in India, the metals and mining industry is vital to the nation's economy (Mehta, P. S. 2002, February). India, a nation abundant in natural resources, has a thriving and active mining and metals industry that is essential to the national economy (Rajput, A. 2021). With its wide spectrum of minerals, metals, and ores, the Indian Metals and Mining sector plays a significant role in the country's industrial growth and GDP (Deb, M., & Sarkar, S. C. 2017). With a past rooted in long-standing mining customs and a future propelled by technology breakthroughs, India's mining industry has transformed into a hub for economic growth, sustainability, and innovation (Baragde, D., & Baporikar, N. 2017).

India has a long history of mining that dates back thousands of years (Mehta, P. S. 2002, February). The nation has a long history of mining, with civilizations extracting minerals, gemstones, and precious metals for commercial and cultural purposes. This tradition is documented in historical writings and archeological findings. This knowledge has been refined and updated over the ages, resulting in the founding of multiple mining firms that conduct business both domestically and abroad (Biswas, A. K. 2001). The striking diversity of mineral riches within the Indian Metals and Mining sector is one of its distinguishing characteristics (MINES, I. B. O. 2018). Large quantities of iron ore, coal, bauxite, copper, zinc, lead, and numerous other industrial minerals are widely available in India. This abundance of minerals makes India a major player in the global mining industry in addition to fostering the expansion of the country's industrial sector (Roonwal, G. S., & Wilson, G. C. 1998). The sector's wide range of offerings meets the needs of multiple industries, such as infrastructure, steel, manufacturing, and energy (Firoz, A. S. 2014). India's mining and metals industry makes a substantial economic contribution to the nation (Mehta, P. S. 2002, February).

Mining businesses encourage economic activities in rural and urban areas by creating jobs, promoting regional growth, and drawing investments (Sarkar, A. N. 2013). The industry contributes much more than just money, it is essential to the development of infrastructure, social welfare programs, and environmental conservation efforts (Kessides, C. 1993). The

Indian mining and metals industry has changed dramatically in recent years, adopting sustainable methods and cutting-edge technologies (Kshitij, G., Khanna, et al. 2022). Mining operations have been transformed by automation, data analytics, and artificial intelligence, which has improved productivity, safety, and environmental stewardship (Young, A., & Rogers, P. 2019). Businesses are putting more and more emphasis on environmentally friendly mining methods to ensure that resources are extracted responsibly and leave as little of an ecological imprint as possible (Fordham, A. E., Robinson, G. M., et al. 2017).

Financial analysis is a critical component of assessing the health and stability of a company (Valaskova, K., Durana, P., et al. 2020). It is essential for investors, creditors, and financial analysts to evaluate the financial position and risk associated with a firm (Beaver, W. H., Correia, M., et al. 2011). Evaluating the financial health of enterprises in this area is crucial since it is a cornerstone of economic progress (Vrbka, J., et al. 2019). Comprehending these organizations' fiscal steadiness and endurance is essential for creditors, investors, and legislators alike (Siegel, J. J. 2021). To assess a company's financial resilience in this setting, academics and financial analysts frequently rely on complex models (Vrbka, J., et al. 2019). The Altman Z-Score and the Zmijewski Models are two well-known models that are used in this study to evaluate and analyze the financial health of particular metals and mining sector organizations (Cakranegara, S. A. S. P. A. 2021).

2. Review of Literature

Based on an analysis of four Indonesian shipping companies' financial difficulties, PT. MBSS is the most stable, while PT. BLT is the least stable (Manalu, S., Octavianus, R. J. N., et al. 2017). PT. Sampoerna Tbk is not in danger of going bankrupt, according to a study that used the Altman and Zmijewski models to forecast insolvency in four Indonesian tobacco companies between 2013 and 2017 (Prabowo, S. C. B. 2019). The most accurate financial distress analysis model in the tourism, hospitality, and restaurant subsector is the Springate model, which has a high accuracy rate of 68.75% (Lestari, R. M. E., Situmorang, M., et al. 2021). The analysis looks at the bankruptcy status of PT Atlas Resources between 2015 and 2017, and it finds a drop in financial performance that raises the possibility of bankruptcy and bad investment decisions (Soelton, M., Muhsin, M., et al. 2019). Indonesian telecommunications businesses from 2014 to 2019 are compared to bankruptcy prediction models from Altman, Springate, Zmijewski, and Grover. The findings indicate that while XL Axiata, Smartfren, Indosat, and PT. Telkom is unhealthy (Fauzi, S. E., & Saluy, A. B. 2021). The impact of the war differs among nations and industries, according to the study, which examines stock market responses to the Russian invasion in 2022. Businesses in EU nations witness a notable decrease in anomalous returns, with the manufacturing and banking industries exhibiting more adverse consequences. According to the report, economic factors have a major role in putting an end to the conflict in Ukraine (Sun, M., Song, H., & Zhang, C. 2022). The effect of COVID-19 on industry efficiency in the stock market of Tehran is investigated in this research. Only nine out of 23 industries in Iran were found to be efficient in 2019 by the study, which used a hybrid model of data mining and data envelope analysis. According to the report, COVID-19 had a major impact on industry performance, causing certain once-productive sectors—like the banking sector—to become less productive the next year (Sarfaraz, A. H., Yazdi, et al.2022). This study looks at the risk exposure of a few chosen companies and the S&P Bombay Stock Exchange (BSE) Energy Index during the COVID-19 epidemic and the Russia-Ukraine conflict. The goal of the study is to give businesses, investors in energy stocks, and the economy a risk exposure matrix. The study examines the state of the energy industry during both crises and assesses how the pandemic and the conflict between Russia and Ukraine have affected the index and particular stocks. According to the study's findings, all ten of the companies have strong growth and return potential (Tarczynska-Luniewska, M., Bak, et al. 2022). This study uses secondary data from the Bombay Stock Exchange website to examine the relationship between risk and return in the Indian fintech industry. The results emphasize the value of taking chances in the Indian fintech sector, which has an impact on the holding periods and portfolio composition of fund managers and stock investors. According to the report, those who are willing to take risks could make substantial profits from the Indian fintech sector (Bhatnagar, M., Özen, E., et al. 2022). Although some contend that mining isn't benefiting fairly from society's shift to low-carbon and circular economies, mining's significance in this process is growing. A lack of trust between society and industry impedes efforts to improve social and environmental performance (Hodge, R. A., Ericsson, M. et al. 2022). The study looks at how ownership arrangements and corporate governance characteristics affect sustainability reporting in Indian firms that are listed on the NSE. It finds that big4 auditing has little bearing on disclosure, but government ownership and board frequency do (Kumar, K., Kumari, R., et al. 2022). In addition to analyzing methods, types of input data, and algorithms, the study evaluates 143 research studies that use data mining techniques to anticipate stock market movements. It also makes recommendations for future research paradigms (Kaur, J., & Dharni, K. 2022). Using quantile regression to examine the causal relationship between aluminum pricing and manufacturing index, the study investigates the effects of COVID-19 on India's aluminum manufacturing industry (Mehta, K., Sharma, R., 2022). In evaluating the effect of COVID-19 on mining operations in India, the study identifies ten green recovery options and fourteen contributing elements. Enhancing management competencies, suggests eco-innovation, health, safety, and environmental awareness (Marimuthu, R., Sankaranarayanan, B., et al. 2022).

3. Research Methodology

Research can be done in two general categories, quantitative research, and qualitative research. Researchers who use secondary data sources as their data sources will employ the quantitative method. Secondary data is information gathered from accessible sources by the Money market, Capitaline, and other authentication sources. This approach gathers information that is objective, scientific, inductive, and yields statistical results. This approach is used to investigate a specific population or sample.

3.1 Sample Size

In this study, the researcher has selected ten Indian Metals and Mining Companies for a period of three years from 2019-20 to 2021-22 with two insolvency prediction models namely Altman's Z-score and Zimjweski's X-score where Altman's Z-score has five variables for analysis of manufacturing industries and four variables for analysis of service sector companies, and Zimjweski's X-score has three variables for analysis to all industries either manufacturing or service.

3.2 Models Specification and Estimation

A financial instrument called a bankruptcy model is used to determine the probability that a business or an individual may experience financial difficulties and be unable to pay their debts. These models forecast the likelihood of bankruptcy using a variety of financial parameters, past data, and statistical techniques. They support the decision-making process for creditors, investors, and analysts when it comes to lending, investing, or conducting business with a certain firm. Models of bankruptcy are essential for risk management and financial planning because they shed light on the stability and health of people's and companies' finances.

3.2.1 Altman' Z-score Model

Altman's Z-score is a financial metric that was developed by Edward Altman in the late 1960s. It is used to predict the likelihood of a business going bankrupt (Altman, E. I., Iwanicz-Drozdowska, M., et al. 2017). The Z-score is based on multiple financial ratios and other factors that are found in a company's financial statements (Manousaridis, C. O. 2017). Altman originally developed the Z-score model for publicly traded manufacturing companies, but it has since been adapted for private companies and non-manufacturing firms as well (Altman, E. I., Iwanicz-Drozdowska, M., et al. 2017).
The Z-score is calculated using the following formula (only for manufacturing industries):

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

Where:
X_1 = Working Capital / Total Assets
X_2 = Retained Earnings / Total Assets
X_3= Earnings Before Interest and Taxes (EBIT) / Total Assets
X_4 = Market Value of Equity / Book Value of Total Liabilities
X_5 = Sales / Total Assets
The Z-score model evaluates these ratios and combines them into a single score. The interpretation of the Z-score is as follows:
Z-score > 2.6: The company is considered safe, and bankruptcy is unlikely.
1.1 < Z-score < 2.6: The company is in a grey area, and caution is needed.
Z-score < 1.1: The company is considered distressed, indicating a higher likelihood of bankruptcy.
(Altman, E. I., Iwanicz-Drozdowska, M., et al. 2017).

3.2.2 Zimjweski's X-score Model

A model of insolvency called the Zmijewski X-Score is used to forecast a company's bankruptcy within two years. Probit analysis was used to determine the ratio used in the Zmijewski score (consider probit as probability unit). Scores below 5 in this instance indicate a higher likelihood of default. Zmijewski pointed out that prior bankruptcy score models favored circumstances with more comprehensive data and oversampled distressed enterprises. There were 40 insolvent and 800 nonbankrupt enterprises used in the analysis (Wati, M. W., Suhadak, S., et al. 2015).

$$\text{Zmijewski Score} = -4.336 - 4.513X_1 + 5.679X_2 + 0.004X_3$$

Where
X_1: Net Income to Total Assets Ratio
X_2: Total Debt to Total Assets Ratio
X_3: Current Assets to Current Debt Ratio
The X-Score typically ranges from -1 to 1($X>0$ and $0<X$). A higher X-Score is considered more favorable, indicating lower bankruptcy risk (Wati, M. W., Suhadak, S., et al. 2015).

3.3 Data Analysis Technique

In this section, the researcher has described about different types of techniques for data analysis. The researcher has used Excel and SPSS for the measurement of both models' values Z-score and X-score. The researcher has also used different types of tests or tools to check the models' impact like descriptive statistical tools and logistic regression.

4. Analysis with Results and Discussion

In this section, the researcher has described about data analysis and their interpretations. The researcher has selected fifty companies for a period of five years with two models namely Altman Z-score and Zimjweski X-score.

4.1 Measurement of Models Value

Financial ratios called the Altman Z-Score and X-Score models are used to evaluate a company's creditworthiness and stability (Winarso, E., & Edison, T. A. 2019). Analysts, investors, and creditors frequently use these models to assess the likelihood of insolvency or other financial difficulties. Let's examine each model and the associated measurements (Lorenzo, R., Valentinuz, G., et al. 2020).

Table-1

Measurement of Altman Z-score and Zimjweski X-score

S.No.	Name of the Company	Years	Altman-Z score	Zones	Zimjweski X-score	Zones
1	ISMT Ltd	2019-20	2.36	Grey	-2.96	Not Bankrupt
		2020-21	5.96	Green	-2.56	Not Bankrupt
		2021-22	7.35	Green	-3.33	Not Bankrupt
2	Ashapura Minechem Ltd	2019-20	2.12	Grey	-1.68	Not Bankrupt
		2020-21	3.56	Green	1.15	Bankrupt
		2021-22	4.40	Green	2.84	Bankrupt
3	Maan Aluminium Ltd	2019-20	2.28	Grey	1.15	Bankrupt
		2020-21	4.52	Green	-2.12	Not Bankrupt
		2021-22	6.44	Green	-2.42	Not Bankrupt
4	Jai Balaji Industries Ltd	2019-20	1.07	Distress	2.69	Bankrupt
		2020-21	2.23	Grey	3.67	Bankrupt
		2021-22	3.94	Green	7.49	Bankrupt
5	Sona Hi Sona Jewellers (Gujarat) Ltd	2019-20	1.05	Distress	-2.15	Not Bankrupt
		2020-21	2.76	Green	-2.18	Not Bankrupt
		2021-22	3.86	Green	-1.89	Not Bankrupt
6	MSP Steel & Power Ltd	2019-20	1.82	Grey	-2.19	Not Bankrupt
		2020-21	2.10	Grey	-1.67	Not Bankrupt
		2021-22	2.70	Green	-1.19	Not Bankrupt
7	Kirloskar Ferrous Industries Ltd	2019-20	1.92	Grey	1.68	Bankrupt
		2020-21	2.52	Grey	2.64	Bankrupt
		2021-22	2.37	Grey	3.01	Bankrupt
8	Gallantt Ispat Ltd	2019-20	1.32	Grey	1.08	Bankrupt
		2020-21	1.85	Grey	2.19	Bankrupt
		2021-22	0.98	Distress	-3.81	Not Bankrupt
9	Jai Corp Ltd	2019-20	2.10	Grey	-3.67	Not Bankrupt
		2020-21	1.73	Grey	-4.28	Not Bankrupt
		2021-22	1.80	Grey	-4.47	Not Bankrupt
10	Pennar Industries Ltd	2019-20	2.12	Grey	-3.56	Not Bankrupt
		2020-21	1.01	Distress	-3.07	Not Bankrupt
		2021-22	1.79	Grey	-2.68	Not Bankrupt

Source: *Researcher self-analysis*

Table 1 describes that there are two models that measure the financial health of the selected Indian Metals and Mining Companies. The table provides financial information about several companies over a period of three years, including their Altman-Z scores and Zimjweski X-scores. These scores are commonly used to assess a company's financial health and bankruptcy risk. ISMT Ltd describes that the Altman-z score has ranged from 2.36 to 7.35 which means low to low low-moderate bankruptcy risk, and the Zimjweski x-score has ranged from -2.96 to -3.33 which means high bankruptcy risk initially, decreasing to moderate. Ashapura Minechem Ltd describes that the Altman-z score has ranged from 2.12 to 4.40 which means low bankruptcy risk initially, increasing to moderate, and the Zimjweski x-score has ranged from -1.68 to 2.84 which means moderate to low bankruptcy risk. Maan Aluminium Ltd describes that the Altman-z score has ranged from 2.28 to 6.44 which means low to moderate bankruptcy risk, and the Zimjweski x-score has ranged from 1.15 to -2.42 which means low to moderate bankruptcy risk. Jai Balaji Industries Ltd describes that the Altman-z score has ranged from 1.95 to 3.94 which means low bankruptcy risk initially, increasing to moderate, and the Zimjweski x-score has ranged from 2.69 to 7.49 which means moderate to low-moderate bankruptcy risk. Sona Hi Sona Jewellers (Gujarat) Ltd describes that the Altman-z score has ranged from 1.98 to 3.86 which means low bankruptcy risk, and the Zimjweski x-score has

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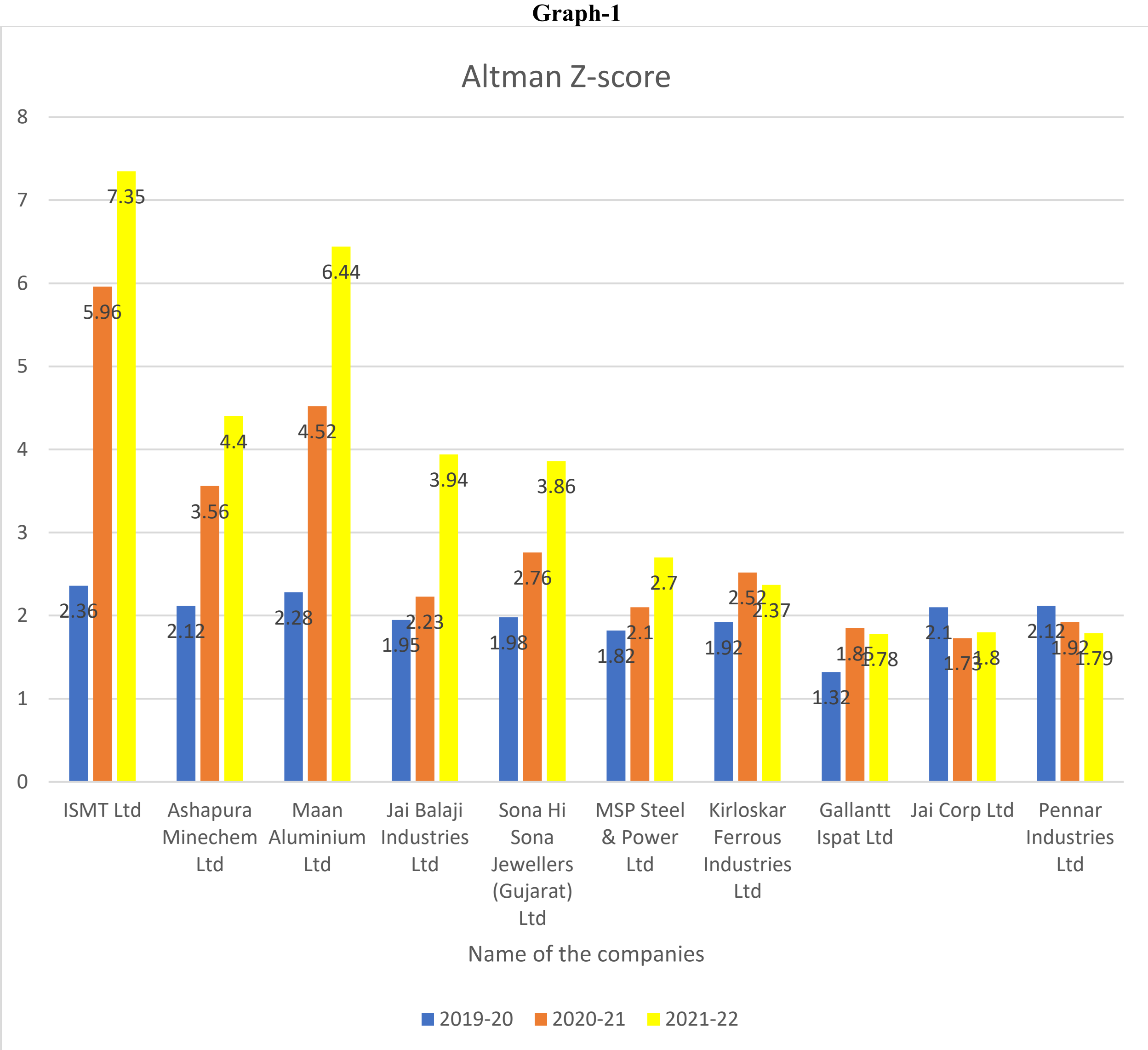
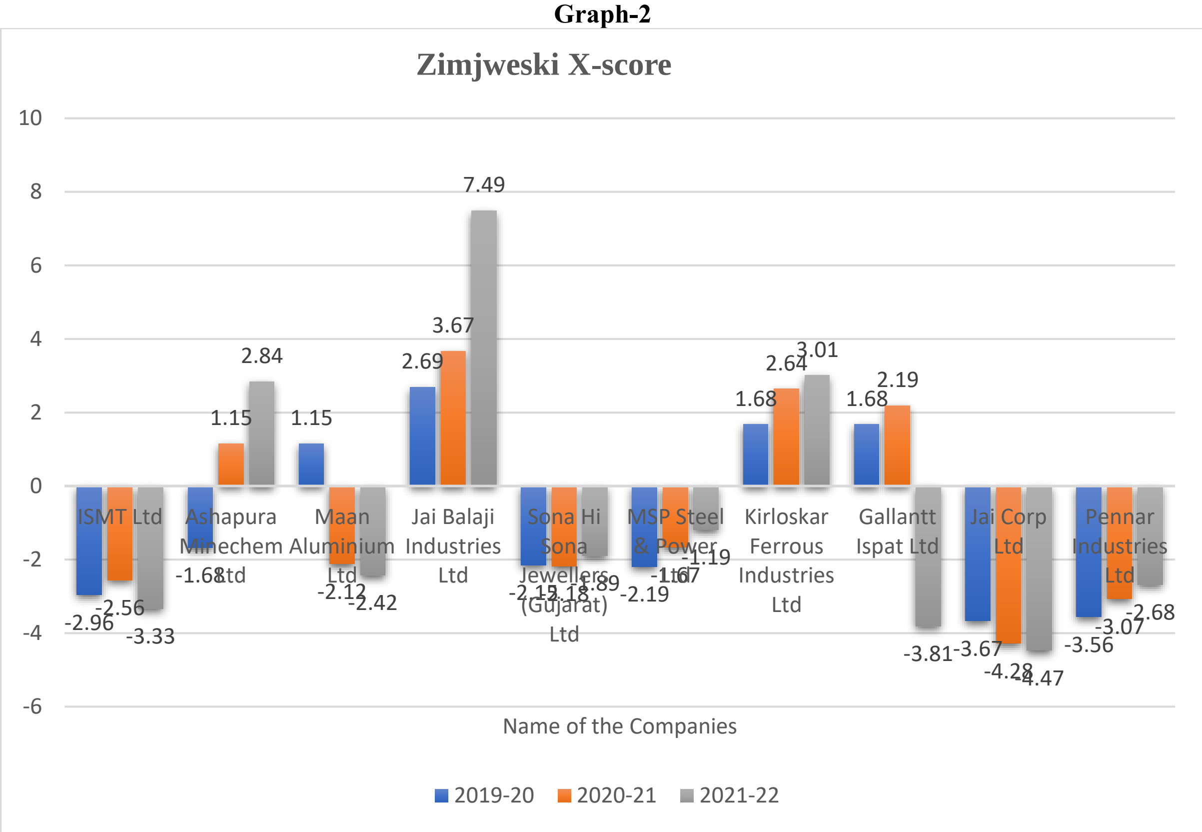
ranged from -2.15 to -1.89 which means moderate bankruptcy risk. MSP Steel & Power Ltd describes that the Altman-z score has ranged from 1.82 to 2.70 which means low bankruptcy risk, and the Zimjweski x-score has ranged from -2.19 to -1.19 which means moderate to low bankruptcy risk. Kirloskar Ferrous Industries Ltd describes that the Altman-Z score has ranged from 1.92 to 2.37 which means low bankruptcy risk, and the Zimjweski x-score has ranged from 1.68 to 3.01 which means low to low-moderate bankruptcy risk. Gallant Ispat Ltd describes that the Altman-z score has ranged from 1.32 to 1.85 which means low bankruptcy risk, and the Zimjweski x-score has ranged from 1.08 to -3.81 which means low to high bankruptcy risk. Jai Corp Ltd describes that the Altman-z score has ranged from 1.80 to 2.10 which means low bankruptcy risk, and the Zimjweski x-score has ranged from -3.67 to -4.47 which means high bankruptcy risk. Pennar Industries Ltd describes that the Altman-z score has ranged from 1.79 to 2.12 which means low bankruptcy risk, and the Zimjweski x-score has ranged from -3.56 to -2.68 which means high bankruptcy risk initially, decreasing to moderate. ISMT Ltd, MSP Steel & Power Ltd, and Kirloskar Ferrous Industries Ltd consistently showed low bankruptcy risk over the three years. Sona Hi Sona Jewellers (Gujarat) Ltd had a consistent but moderate bankruptcy risk. Ashapura Minechem Ltd and Maan Aluminium Ltd started with low bankruptcy risk but moved to a moderate level. Jai Balaji Industries Ltd started with low risk but increased to moderate risk. Gallant Ispat Ltd, Jai Corp Ltd, and Pennar Industries Ltd had low bankruptcy risk initially but showed a trend towards higher risk, especially according to the Zimjweski X-Score.

Graph-1

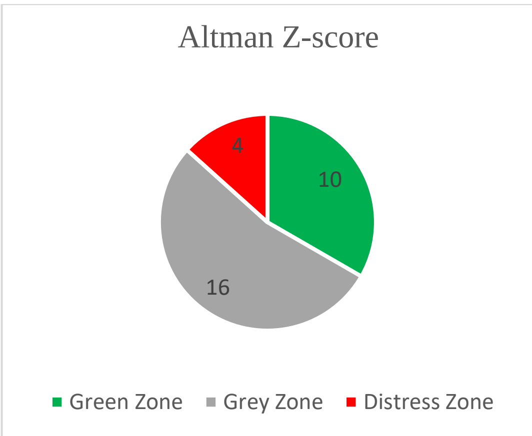


Graph-2

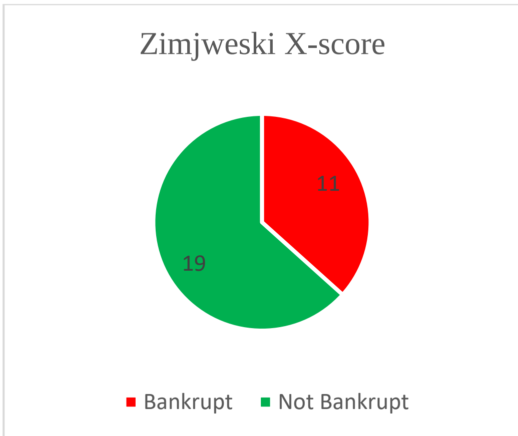


Graphs 1 and 2 describe that what is the difference between both models, in these two models one is the Altman z-score which describes all ten selected Indian metals and mining companies for the period of three years and most of the companies are in the grey zone, and green zone and a few companies in distress zone and the Zimweski x-score model which describes all ten selected Indian metals and mining companies for the period of three years and most of the companies are in the Not bankrupt and a few companies in the Bankrupt.

Pie Chart-1



Pie Chart-2



Pie Charts 1 and 2 describe how many companies lie in either green, grey and distress zones or bankrupt and not bankrupt through both selected models for the period of three years. Pie chart 1 is related to the Altman z-score models which overall describe that for 16 years companies lay in the grey zone, 10 years companies lay in the green zones, and only four years companies lay in the distress zones. Pie chart 2 is related to the Zimjweski x-score model which overall describes that 19 years of the selected companies have not been bankrupted and only 11 years of the selected companies have been bankrupted.

4.2 Testing of variables

In this section, the researcher has described the result of the descriptive statistical analysis of both models.

Table-2
Impact of Altman Z-score Model

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Z-score	10	5.6	1.8	7.4	3.650	.6240	1.9733	3.894	.943	.687	-.112	1.334
Valid N (listwise)	10											

The above table describes that N (Sample Size) is 10 observations in the dataset. The range represents the difference between the maximum and minimum values. In this case, it is 5.6 (7.4 - 1.8), showing the spread of Z-score values within the sample. The Minimum Z-score in the sample is 1.8. This indicates the lowest financial stability score in the dataset. The Maximum Z-score in the sample is 7.4, indicating the highest financial stability score in the dataset. The mean (Average) Z-score in the sample is 3.65. This gives you a measure of the central tendency of the dataset. The standard deviation measures the dispersion or spread of values around the mean. In this case, it is approximately 1.97. A higher standard deviation suggests that the values are spread out over a wider range. Variance is the square of the standard deviation. It quantifies the amount of variation or dispersion in the dataset. In this case, it is approximately 3.89. Skewness measures the asymmetry of the distribution. A positive skewness (in this case, 0.687) indicates that the distribution is skewed to the right, meaning it has a longer tail on the right side. Kurtosis measures the 'tailedness' of the data distribution. A positive kurtosis (in this case, 1.334) indicates that the distribution has heavier tails and a sharper peak than a normal distribution. Valid N (Listwise) indicates that there are 10 valid, non-missing observations in the dataset. This means that there are no missing values in the Z-score variable for these 10 cases.

Table-3
Impact of X-score Model

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
X-score	10	12.0	-4.5	7.5	-.650	1.2136	3.8376	14.727	1.248	.687	.821	1.334
Valid N (listwise)	10											

The above table describes that N (Number of Observations) is 10 observations in the dataset. The range is the difference between the maximum and minimum values. In this case, the range is 12.0 (from -4.5 to 7.5). The Minimum value in the dataset is -4.5. The Maximum value in the dataset is 7.5. The mean (Average) value of the X-score in the sample is approximately -0.65. Standard Deviation measures the amount of variation or dispersion of a set of values. A low standard deviation indicates that the values tend to be close to the mean. Here, the standard deviation is approximately 1.2136. Variance is the square of the standard deviation. It measures how much each number in the dataset differs from the mean. The variance is approximately 3.8376. Skewness measures the asymmetry of the probability distribution of a real-valued random variable about its mean. Positive skewness indicates a distribution that is skewed right, while negative skewness indicates a distribution that is skewed left. Here, the skewness is 14.727, indicating a highly skewed distribution. Kurtosis measures the "tailedness" of the probability distribution. High kurtosis (in this context, greater than 3) indicates heavy tails or outliers. The kurtosis here is 0.687, which suggests a distribution close to the normal distribution (which has a kurtosis of 3). Valid N (listwise) indicates that there are 10 valid cases in the analysis. "Listwise" means that cases with missing data were excluded from the analysis.

4.3 Compare the result

In this section, the researcher has described the outcomes of testing and compared with whole result between both models.

Table-4
Case Processing Summary

	Cases					
	Included		Excluded		Total	
	N	Percent	N	Percent	N	Percent
Z-score	10	100.0%	0	0.0%	10	100.0%
X-score	10	100.0%	0	0.0%	10	100.0%

The above table describes case processing for two categories, "Z-score" and "X-score." The table is organized into three columns: "Included," "Excluded," and "Total." Each column represents the number and percentage of cases falling into the respective category.
The Z-score Category included category has 10 cases in the Z-score category, representing 100% of the cases in this category, the excluded category has 0 cases excluded from the Z-score category, accounting for 0% of the cases, and the total number of cases in the Z-score category is 10, constituting 100% of the total cases.
The X-score Category included category Similar to the Z-score category, there are 10 cases included in the X-score category, representing 100% of the cases in this category, the excluded category has 0 cases excluded from the X-score category, making up 0% of the cases, and the total number of cases in the X-score category is 10, accounting for 100% of the total cases.

Table-5
Comparative Report

	Z-score	X-score
Mean	3.650	-.650
N	10	10
Std. Deviation	1.9733	3.8376
Std. Error of Mean	.6240	1.2136
Minimum	1.8	-4.5
Maximum	7.4	7.5
Range	5.6	12.0
Kurtosis	-.112	.821
Std. Error of Kurtosis	1.334	1.334
Skewness	.943	1.248
Variance	3.894	14.727

The above table describes that the Mean represents the average value of the data points in each dataset. The mean of the Z-score dataset is 3.650, while the mean of the X-score dataset is -0.650. N shows the number of data points in each dataset. Both datasets have 10 data points. Standard Deviation measures the dispersion or spread of the data points. A lower standard deviation indicates that the data points tend to be closer to the mean. The Z-score dataset has a standard deviation of approximately 1.9733, while the X-score dataset has a higher standard deviation of approximately 3.8376. Standard Error of Mean represents the standard deviation of the sampling distribution of the mean. It gives an idea of how much the sample mean is expected to vary from the true population mean. The Z-score dataset has a standard error of a mean of 0.6240, and the X-score dataset has a standard error of a mean of 1.2136. Minimum and Maximum values represent the smallest and largest data points in each dataset, respectively. For the Z-score dataset, the minimum value is 1.8, and the maximum value is 7.4. For the X-score dataset, the minimum value is -4.5, and the maximum value is 7.5. The range is the difference between the maximum and minimum values in each dataset. The range for the Z-score dataset is 5.6, and for the X-score dataset, it is 12.0. Kurtosis measures the "tailedness" of the probability distribution of a real-valued random variable. Negative kurtosis (like in the Z-score dataset) indicates a distribution that is less outlier-prone than a normal distribution, whereas positive kurtosis (like in the X-score dataset) indicates a distribution with heavier tails and more outliers. Standard Error of Kurtosis represents the standard deviation of the sampling distribution of kurtosis. It indicates the variability of kurtosis in different samples. Skewness measures the asymmetry of the probability distribution of a real-valued random variable about its mean. Positive skewness (like in both datasets) indicates a distribution that is skewed to the right, meaning that the right tail is longer or fatter than the left. Variance is another measure of the spread of data points. It is the average of the squared differences from the Mean. The Z-score dataset has a variance of approximately 3.894, while the X-score dataset has a variance of approximately 14.727.

5. Limitations and Suggestions

The research uses secondary data sources, but it has drawbacks like data availability issues and potential mistakes. The sample size is small, with only ten Indian Metals and Mining Companies. A larger sample size would provide more reliable results. The study uses two models for predicting financial stability, the Zimjewski X-score and Altman Z-score, but their suitability for the Indian Metals and Mining industry is discussed. To improve data accuracy and statistical power, researchers should cross-reference data from multiple sources and confirm it with financial reports. Expanding the sample size and extending the data collection period can provide a deeper understanding of financial stability cycles in the mining and metals sector. Confirming the efficacy of financial models like Zimjewski X-score and Altman Z-score, conducting sensitivity analyses, and incorporating qualitative data from interviews can provide more insights. The findings can help investors, creditors, and legislators make informed decisions, and suggest strategies for businesses to strengthen risk management and financial stability.

6. Conclusion

The mining and metals sector, being integral to the global economy, relies heavily on financial stability for sustained growth and development. Through a comprehensive study spanning three years, ten major companies were evaluated, shedding light on their creditworthiness and potential risks of insolvency. The application of the Altman Z-score and Zmijewski X-score models allowed for a nuanced understanding of these companies' financial positions. The Altman Z-score model, taking into account various financial ratios, categorized the companies into different risk zones. Notably, ISMT Ltd, MSP Steel & Power Ltd, and Kirloskar Ferrous Industries Ltd consistently demonstrated low bankruptcy risk over the three years, indicating their stable financial position. In contrast, companies like Jai Balaji Industries Ltd and Pennar Industries Ltd experienced fluctuations, moving from low to moderate risk levels. The Zmijewski X-score model, considering parameters such as net income to total assets ratio and total debt to total assets ratio, further reinforced these findings. The results showed that most companies were not at risk of bankruptcy, with only a few experiencing higher risk levels. The data highlighted the industry's overall stability, with occasional fluctuations in individual companies' financial health. Analyzing the descriptive statistics provided additional insights. The Z-score dataset exhibited a normal distribution with low kurtosis, suggesting a balanced spread of data points around the mean. In contrast, the X-score dataset displayed positive kurtosis, indicating heavier tails and more outliers. This information is crucial for investors and creditors, offering a comprehensive view of the industry's financial landscape. The study underscores the importance of robust financial analysis in the mining and metals industry. The findings not only offer valuable insights to investors and creditors but also serve as a benchmark for companies within the sector, enabling them to make informed financial decisions. As the industry continues to evolve, ongoing financial analysis remains imperative for ensuring its stability and contributing significantly to the global economy The study uses secondary data sources but faces issues like data availability and potential mistakes. The sample size is small, with only ten Indian Metals and Mining Companies. To improve data accuracy, researchers should cross-reference data, confirm it with financial reports, and expand the sample size. The findings can help investors, creditors, and legislators make informed decisions.

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