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Accuracy of Bankruptcy Prediction Models for Coal Companies in Indonesia

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ABSTRACT

Purpose - This research aims to conduct analysis of the accuracy of predictions of company bankruptcy using 3 main models, namely the Modified Altman, Springate and Zmijewski models. Methodology - The type of research used is comparative descriptive research.The population in this research are companies registered as coal mining companies listed on the Indonesia Stock Exchange throughout 2020-2022. By using a purposive sampling technique, research data was obtained from 22 coal sub-sector mining companies, so that a total of 66 observations were obtained. Findings - There is 1 company that will consistently experience potential bankruptcy prediction, namely ARXX, has been established since 2007, which in the last 6 years has experienced very poor financial performance, because the company has debts that continue to accumulate, and problematic assets caused by non-operating subsidiaries. The results show that the Zmijewsky Model is the bankruptcy prediction model with the highest level of accuracy, next is the Modified Altman Model and finally the Springate Model. It is known that the three bankruptcy prediction models, namely the Modified Altman, the Springate and the Zmijewsky Model, have significant differences, where each model focuses on assessing bankruptcy predictions on different aspects.

Introduction

The widespread spread of the corona virus in early 2020 also put pressure on the domestic financial market, especially the Indonesian stock exchange. Coal mining issuers were also under pressure because export supplies were disrupted due to several Chinese factories having to close as a result of policies during the corona outbreak where many workers were furloughed. In fact, as is known, China is the main and mainstay coal export destination for Indonesia. This condition has resulted in negative sentiment among coal mining issuers in Indonesia. The performance of coal issuer shares YTD 2023 experienced a decline until it reached its lowest point since June 2021. Throughout July 2023, coal prices always closed in the red zone, up to 17.09%. Since the beginning of the year, coal prices have fallen by 67%. The erratic fluctuations in coal prices from year to year and the tendency to experience significant declines in share prices mean that this industrial sector is included in the high risk business category. Investors must be able to identify risks related to the financial health of the companies they will invest in, and one way is to identify companies that are predicted to experience

potential bankruptcy so that investments with high risks can be avoided. The researchers formulated several criteria in categorizing a company as experiencing bankruptcy (financial distress). Hofer (1980) and Whitaker (1999) in Almilia (2006) define company bankruptcy as a condition of a company experiencing negative net income for several years.

Several common and frequently used bankruptcy prediction models are the Altman Z-Score Modification model or Altman Modification (1968), Springate (1978), and Zmijewski (1983). Rizki (2019), in his research predicting bankruptcy in construction companies on the Indonesia Stock Exchange in 2014-2018, concluded that the Modified Altman model is the model that has the highest level of accuracy when compared to the Falmer, Grover, Springate, and Zmijewski models. According to Edi and Tania (2018) stated that the Springate model is a model that has the highest level of accuracy when compared to the Altman Z-Score, Zmijewski, and Grover prediction models in predicting bankruptcy in companies listed on the Indonesia Stock Exchange during the 2012-2016 period. . Meanwhile, according to Fitri (2016), he concluded that the Zmijewski model is the model that has the highest level of accuracy when compared to the Altman Z-Score and Springate models. From the statement above it can be seen that each bankruptcy prediction model has a different level of accuracy in the company sector studied. To date, no research results have been found regarding determining the accuracy of bankruptcy predictions, especially for coal companies in Indonesia.

Literature review

According to Karissa (2020), bankruptcy can be caused by internal and external factors of the company. Internal factors that can result in bankruptcy include: 1). Inefficient and poor management performance, 2). Unbalanced amount of company debt and capital, 3). There is a high incidence of corporate financial irregularities. There are several opinions regarding the indicators that describe a company experiencing bankruptcy. (Ashraf et al., 2019) states that a company experiences bankruptcy if: 1). companies that fail to pay annual listing fees for two consecutive years are in the early stages of distress, and 2). Reduce or eliminate dividend payments for five consecutive years. According to Halte et al. (2018) that bankruptcy prediction involves developing statistical models that can predict the financial failure or success of a company based on publicly available information such as financial variables from financial reports. Bankruptcy prevention not only extends the economic life of a company and enhances its financial performance, but also serves to improve the economic well-being of a country as a whole. (Ashraf et al., 2019).

Some of the main corporate bankruptcy models that have been developed to date are 1). The Modified Altman Model is a statistical technique used to predict company bankruptcy. The greater the Z value, the greater the guarantee of the company's survival and the risk of failure will be reduced. Altman Z-Score has undergone 3 changes. The final model developed by Altman is the Modified Altman Z-Score Model (Altman Modification) (1995) which can be used by various types of industry (including non-manufacturing) both public and private, with the following formulation:

$$\text{Z-Score} = 6{,}56X1 + 3{,}26X2 + 6{,}72X3 + 1{,}05X4$$

A value above 2.60 is very unlikely to go bankrupt and a value below 1.10 means the company has a high chance of going bankrupt. 2). The Springate Model (S-Score), a model for predicting company bankruptcy that was developed in 1978, is a ratio model that uses multiple discriminant analysis (MDA) which is considered capable of best distinguishing between bankrupt and non-bankrupt sound businesses, with the following formulation:

$$S = 1{,}03(WCTA) + 3{,}07(EBITTA) + 0{,}66(EBTCL) + 0{,}4(SATA)$$

If the S-score value is more than 0.862, then the company is predicted to be a healthy company (no potential for bankruptcy). Meanwhile, if the S-score value is less than 0.862, then the company is predicted to have the potential to experience bankruptcy (Primasari, 2017:28). 3). Zmijewski Model (X-Score), namely a company bankruptcy prediction model, where Zmijewski conducted research on all companies listed on the American and New York Stock Exchanges during the period 1972 to 1978. (Zmijewski, 1984:63). Zmijewski expanded his studies in predicting bankruptcy by increasing the

validity of financial ratios as a tool for detecting company financial failure. The financial ratios analyzed are return on assets, debt ratio, and current ratio, with the following formulation:

$$X = -4,3 - 4,5(NITA) + 5,7(TLTA) - 0,004(CACL)$$

The cutoff value that applies to this model is zero. Companies that have an X-score value greater than or equal to 0 are predicted to experience potential bankruptcy in the future. On the other hand, if the X-score is less than 0, then the company will not experience potential bankruptcy.

Research Methods

The type of research used is comparative descriptive research. The population in this research are companies registered as coal mining companies listed on the Indonesia Stock Exchange throughout 2020-2022. The samples used as research objects were determined using a purposive sampling technique, with the criteria used being based on two things, namely: 1). The coal company is listed on the Indonesian Stock Exchange consecutively in the 2020-2022 period, and 2). The coal company publishes audited financial reports consistently from 2020-2022.

Table 1. Population and Sample

Description	Amount
Coal mining population	23
Data on coal companies that do not meet the criteria	1
Total sample of coal mining companies	22
Total observasions (x 3)	66

(Sources: IDX, 2022, data is processed)

The sample in this study was 22 coal sub-sector mining companies listed on the Indonesia Stock Exchange which fell within the sample criteria required by the researcher. So, the total observations carried out for 3 years, namely the 2020-2022 period, were 66 observations. In this report, the names of the companies observed are not mentioned with their actual names and company codes, as an effort to maintain the company's research code of ethics and confidentiality.

The type of data used in this research is secondary data. The data collection technique in this research is literature study and archival data collection from financial reports of coal sub-sector companies for the period 2020 - 2022 which are published to the public via the website http://www.idx.co.id/.

To make it easier to group large amounts of data using DER, NPM and ROA indicators, this research used the clustering method. The clustering process was carried out using the K-means cluster method, where the number of clusters was determined by the researcher himself with differentiating variables, namely DER, NPM, and ROA to classify whether the company experienced bankruptcy or not.

Table 2. Operationalization Variables

Model	Operastonalization Variables	Bankcruptcy Indicator
Altman Modification	• Working Capital/Total Assets (WCTA) • Reatined Earning/Total Assets (RETA) • Earning Before Interest & Taxes/Total Assets (EBITTA) • Market Value of Equity/Book Value of Debt (MVEBVD) *Z-Score = 6,56 (WCTA +3,26 RETA + 6,72 EBITTA + 1,05 MVEBVD*	Z score < 1,1
Springate	• Working Capital/Total Assets (WCTA) • Earning Before Interest & Taxes/Total Assets (EBITTA) • Earning Before Taxes/Current Liabilities (EBTCL)	S score < 0,862

Model	Operastonalization Variables	Bankcruptcy Indicator
	• Sales/Total Assets (SATA) *S = 1,03 WCTA + 3,07EBITTA + 0,66 EBTCL + 0,4 SATA*	
Zmijewski	• Net Income/Total Assets (NITA) • Total Liabilities/Total Assets (TLTA) • Current Assets/Current Liabilities (CACL) *X = -4,3 - 4,5 NITA + 5,7TLTA - 0,004 CACL*	X score > 0

(Source: processed by researchers from various previous research journals)

In the analysis of different tests containing more than 2 groups of samples, different tests can be carried out using the ANOVA test or using the Kruskal Wallis Test and for normality tests using the Kolmogorov-Smirnov test method. To measure model accuracy with the following formula:

$$\% \text{ Level Accuracy} = \frac{\text{Number of Correct Predictions}}{\text{Number of Observasions}} \text{ x } 100\%$$

error measurement=100 -% Model Accuracy Model

The % model accuracy value ranges from 0% – 100%, the greater the percentage accuracy level, the higher the model's ability to predict bankruptcy.

Results and Discussion

This research was conducted on 22 mining sector companies, especially coal production and service companies which have complete financial reports and are published on the Indonesia Stock Exchange (IDX). The financial reports used as research objects come from the financial position report, profit and loss report, and equity change report. Because it still measures bankruptcy predictions, to maintain the company's research code of ethics and confidentiality, the company's stock code is disguised as shown in the following table.

Table 3. List of Mining Sector Companies Researched

No.	Company Code	Sector	No.	Company Code	Sector
1	ADXX	Coal Production	12	HRXX	Coal Production
2	ARXX	Coal Production	13	INXX	Coal Production
3	BOXX	Coal Production	14	ITXX	Coal Production
4	BSXX	Coal Production	15	KKXX	Coal Production
5	BUXX	Coal Production	16	MBXX	Coal Production
6	BYXX	Coal Production	17	MYXX	Oil, Coal Gas Equipment and Services
7	DEXX	Oil, Coal Gas Equipment and Services	18	PKXX	Oil, Coal Gas Equipment and Services
8	AIXX	Coal Production	19	PBXX	Oil, Coal Gas Equipment and Services
9	DSXX	Coal Production	20	PRXX	Oil, Coal Gas Equipment and Services
10	GEXX	Coal Production	21	SMXX	Coal Production
11	GTXX	Coal Production	22	TOXX	Coal Production

Return on Assets (ROA) is a ratio that measures the efficiency and profitability of a company by comparing net profit with the total assets owned by the company. As a general rule of thumb, an ROA that is higher than the industry average is an indicator that the company's ROA is considered good. Additionally, it is important to consider ROA trends over time. If a company's ROA increases from year to year, it indicates an increase in the company's profitability and efficiency. In table 4, the

following shows the development of the average value of ROA for coal companies during the 3 periods 2020-2022.

Table 4. Average ROA of Coal Companies

Parameter	2020	2021	2022
Average ROA	0,03	0,09	0,23

Based on table 4. above, it can be seen that during the 2020-2022 period there is a tendency for the ROA value to continue to increase every year.

Debt to Equity Ratio (DER) is a financial ratio that compares the amount of debt of a company with the amount of equity in that company. This ratio provides an overview of the extent to which a company finances its operations with debt compared to its own capital. In table 5 below, it is known that the average DER of coal companies has experienced a continuous increase from 2020-2022.

Table 5. Average DER of Coal Companies

Parameter	2020	2021	2022
Average DER	1,63	2,85	3,11

A very high DER value for a company means that the company has a very significant level of debt compared to the capital invested by the owner. This condition causes companies to face financial difficulties in fulfilling obligations for interest payments and dealing with maturing debts, this can lead to the potential for bankruptcy.

Net Profit Margin (NPM) is a financial ratio that measures the profitability of a company by comparing net profit with operational income or sales. NPM indicates how efficient the company is in generating profits from each unit of income earned. In table 6 below, it is known that fluctuations in NPM values occurred during the 2020-2022 period.

Table 6. Average NPM of Coal Companies

Parameter	2020	2021	2022
Average NPM	-0,01	-0,47	0,21

In table 6. It is generally known that companies have low NPM in 2020 and 2021 then improve in 2022. A company that experiences negative profits for 2 consecutive years is an indication that the company is experiencing potential bankruptcy.

In this research, looking at the variability of data distribution, it was determined that the companies observed were divided into 8 clusters, to assess the similarity of the objects in the research sample. To increase the number of objects in each cluster, the population used in this clustering process was 33 companies in the energy sector, including 22 coal companies which were the research objects.

Based on the results of categorizing the financial condition of coal companies using K-means clustering, ARXX, BOXX, and BUXX companies are predicted to experience potential bankruptcy for 3 consecutive years between 2020 and 2022.

Modified Altman Model Analysis

The Modified Altman model formulation will obtain the Altman Z Score index score for each coal company on the IDX for 2020-2022 as in the following table:

Table 10. Financial Index Score of Modified Altman Model Coal Company

Company Code	2020	2021	2022	Company Code	2020	2021	2022
ADXX	6,79	7,94	10,45	HRXX	19,20	10,34	14,12
ARXX	-0,54	0,57	1,93	INXX	5,16	5,69	7,23
BOXX	2,41	-1,38	4,02	ITXX	8,97	8,33	14,55
BSXX	9,17	10,35	12,00	KKXX	10,46	12,03	11,65

BUXX	-1,21	-0,08	-0,56	MBXX	13,25	11,50	15,13
BYXX	7,77	12,72	14,30	MYXX	14,18	17,83	17,33
DEXX	3,78	4,27	3,66	PKXX	2,06	-0,38	-4,43
AIXX	9,82	4,27	7,70	PBXX	7,56	8,83	11,54
DSXX	5,43	7,26	8,68	PRXX	6,14	6,38	6,92
GEXX	6,63	7,82	8,87	SMXX	4,93	7,30	14,45
GTXX	6,84	5,95	6,87	TOXX	4,90	5,19	6,84

From table 10 above, it is known that the overall results of the Z-Score index values for the 22 companies show that the majority of companies are still in a healthy status during 2020-2022. It should be noted that a company that is predicted to have the potential to experience bankruptcy in the year under study does not mean that the company will definitely experience bankruptcy, this is only an early warning system for the company regarding the company's current condition so that the company needs to immediately take anticipatory steps as early as possible. what will happen to the company in the future as well as taking steps to improve performance and management at the company.
The results of comparing the calculations of the Modified Altman Model with K-Means Clustering every year, the results obtained are as below:

Table 11. Alignment of Modified Altman Model Results with K-Means Clustering

Year	Correct Predictions	Incorrect Predictions	
		Type I Error	Type II Error
2020	20	2	-
2021	21	1	-
2022	21	2	-
Total	61	5	-
Total sample size	66	66	66
Percentage	92,4%	7,6%	0%

Thus, the Modified Altman Model has an accuracy rate of 92.4% with K-means clustering results.

Springate Model Analysis

The results of calculating index scores using the Springate Model formulation for each coal company on the IDX for 2020-2022 are shown in the following table:

Table 12. Financial Index Score of Springate Model Coal Company

Company Code	2020	2021	2022	Company Code	2020	2021	2022
ADXX	0,423	1,090	2,739	HRXX	1,678	1,681	2,749
ARXX	-0,421	-0,141	0,309	INXX	0,352	0,784	1,572
BOXX	-0,253	-1,141	1,103	ITXX	0,885	2,002	3,631
BSXX	1,310	2,710	3,850	KKXX	-0,247	1,465	1,931
BUXX	-0,285	0,192	-0,088	MBXX	2,197	2,097	4,126
BYXX	1,343	3,990	4,391	MYXX	1,878	2,701	1,666
DEXX	0,184	0,261	0,283	PKXX	0,371	-0,121	-0,343
AIXX	0,660	0,546	1,379	PBXX	1,080	5,211	1,665
DSXX	0,360	0,854	2,179	PRXX	0,414	0,522	0,677
GEXX	1,180	2,517	3,315	SMXX	-0,124	1,170	3,083
GTXX	-0,188	-0,236	0,545	TOXX	0,691	0,680	1,319

From table 12. above, it is known that there are 14 companies that are predicted to experience potential bankruptcy in 2020, then this decreases in 2021 to 11 companies and finally decreases again in 2022 to 6 companies.

The results of comparing the calculations of the Springate Model with K-Means Clustering every year, obtained the results as below:

Table 13. Alignment of Springate Model Results with K-Means Clustering

Year	Correct Predictions	Incorrect Predictions	
		Type I Error	Type II Error

2020	12	-	10
2021	16	-	6
2022	18	1	3
Total	46	1	19
Total sample size	66	66	66
Percentage	69,7%	1,5%	28,8%

From table 13 above, it is known that the accuracy value of the Springate model with K-Means Clustering is 69.7% with incorrect predictions.

Zmijewski Model Analysis

The results of score calculations using the Zmijewski model formulation for each coal company on the IDX for 2020-2022 are shown in the following table:

Table 14. Financial Index Score of Zmijesky Model Coal Company

Company Code	2020	2021	2022	Company Code	2020	2021	2022
ADXX	-2,17	-2,45	-3,25	HRXX	-4,50	-3,50	-4,74
ARXX	1,02	0,81	0,13	INXX	-0,21	0,03	-1,05
BOXX	0,60	2,52	0,65	ITXX	-2,99	-3,42	-4,82
BSXX	-3,27	-3,64	-4,57	KKXX	-2,67	-3,41	-3,71
BUXX	0,88	0,88	-0,35	MBXX	-3,73	-3,43	-5,04
BYXX	-1,59	-4,24	-5,37	MYXX	-3,93	-4,50	-4,14
DEXX	-1,38	-1,35	-1,12	PKXX	-1,74	-1,81	1,82
AIXX	-2,50	-1,62	-3,10	PBXX	-2,86	-5,39	-4,14
DSXX	-1,29	-2,33	-0,35	PRXX	-1,19	-1,36	-1,79
GEXX	-1,80	-2,55	-3,24	SMXX	-2,26	-3,29	-4,94
GTXX	-2,87	-2,63	-3,04	TOXX	-1,16	-1,18	-1,77

According to the Zmijewski model, companies with a score of > 0 are categorized as companies that have the potential to experience potential bankruptcy.

The results of comparing the calculations of the Zmijewsky Model with K-Means Clustering every year, obtained the results as below:

Table 15. Alignment of Zmijewsky Model Results with K-Means Clustering

Year	Correct Predictions	Incorrect Predictions	
		Type I Error	Type II Error
2020	21	1	-
2021	21	1	-
2022	21	1	-
Total sample size	63	3	-
Percentage	95,5%	4,5%	-

It is known that the accuracy value of the Zmijewsky Model with K-Means Clustering is 95.5%.

The following is a summary of the descriptive statistical analysis of all bankruptcy prediction

models used, namely:

Table 16. Descriptive Statistics of Prediction Models

Parameter/Model	Altman Modifikasi	Springate	Zmijewsky
Mean	7,57	1,28	-2.23
Standard Error	1,00	0,23	0.37
Standard Deviation	4,67	1,07	1.72
Sample Variance	21,81	1,14	2.96
Minimum	-0,92	-0,10	-4.25
Maximum	16,45	3,24	1.26
Indikasi *Distress*	<1,1	<0,862	>0

Based on the table above, it is known that the Modified Altman Model has the highest standard deviation value of 4.67 compared to the other two models, meaning that the sample data in the Modified Altman model has a larger data distribution and is more varied than the average value. Meanwhile, the Springate Model has the lowest standard deviation value of 1.07 compared to the other two models, which illustrates that the distribution of value scores does not deviate too much from the average value. Based on the results of the normality test using the Kolmogorov-Smirnov and Shapiro Wilk normality tests, the test results show that the Modified Altman, Springate and Zmijewsky models have a significance of > 0.05, so it can be concluded that the data is normally distributed.

Based on the calculation results of the bankruptcy prediction model according to the Modified Altman, Springate, and Zmijewsky models, it can be seen which model has the highest level of precision (accuracy) by using actual financial data and using K-means clustering. The results are as summarized in the table below :

Table 17. Summary of the Accuracy of Each Model with K-Mean Clustering Results

Parameter/Metode	Altman Modifikasi	Springate	Zmijewsky
Accuracy	92,4%	69,7%	95,5%

From the table 17 above, it is known that the model with bankruptcy predictions that has the highest level of accuracy (accuracy) for coal mining companies during the 2020 – 2022 period is the Zmijewsky Model with an accuracy level of 95.5% followed by the Modified Altman Model of 92, 4% and the Springate Model with the lowest level of accuracy, namely 69.7%. The results of this research are in line with the results of research by Monica (2021) who conducted research on 20 mining companies from 2016-2020 where the Zmijewsky method was considered the best model for predicting bankruptcy compared to the Altman Z-Score, Grover, and Springate models. The results of Elia's research (2021), which conducted research on the retail sector in Indonesia, showed that the Grover Model had higher accuracy than the Springate Model. However, the results of this research are not in line with the research results of Suidarma et al (2021) which show that the Zmijewsky model is only able to predict the financial condition of coal companies in the 2015-2019 period by 45.45%, while in this research the Modified Altman model is considered the most capable of predicting accuracy up to 92.4%.

Conclusion

From the results of the discussion in this research, it can be concluded that:

Based on the Modified Altman Model, during the 2020-2022 period there were 2 companies that consistently experienced predictions of potential bankruptcy, namely ARXX and BUXX. According to the Springate Model, it is predicted that there are 6 companies that consistently experience the potential for bankruptcy, namely ARXX, BUXX, DEXX, GTXX, PKXX, and PRXX. Meanwhile, according to the Zmijewski Model, it is predicted that there are 2 coal mining companies that consistently experience the potential for bankruptcy, namely ARXX and BOXX. Thus, based on the overall prediction model, there is 1 coal mining company that consistently experiences potential bankruptcy during the 2020-2022 period, namely ARXX, one of the coal producers in Indonesia which has been established since

2007, which in the last 6 years has experienced very poor financial performance. because the company has debts that continue to accumulate, problematic assets caused by non-operating subsidiaries, and continues to experience negative profit balances so that the company is unable to provide dividends to its shareholders.Based on the results of statistical tests, it is concluded that the Zmijewsky Model is the highest potential bankruptcy prediction model, namely 95.5%, followed by the Modified Altman Model with an accuracy rate of 92.4% and finally the Springate Model with the lowest accuracy rate of 69. 7%. Based on the results of the ANOVA test (Kolmogorov-Smirnov and Shapiro-Wilk), it is known that the three potential bankruptcy prediction models, namely the Modified Altman Model, Springate Model and Zmijewsky Model, have significant differences, each of which focuses on different aspects in predicting the Company's potential bankruptcy.

Suggestion

1. For further research, it is recommended that company bankruptcy predictions be developed that involve more other financial ratios, for example Debt Ratio, Return on Equity (ROE), and Operating Profit Margin (OPM) and even other non-financial variables to provide more comprehensive prediction results.

2. For further research, it is recommended to expand the sample period so that more and broader data is obtained in order to obtain more comprehensive research results.

3. For companies in the coal sector listed on the IDX that will carry out financial analysis, the Zmijewsky model is appropriate to use to predict the company's potential bankruptcy because based on this research, this model has been proven to have the highest level of accuracy in predicting the company's potential bankruptcy by taking into account The most dominant aspect is regarding the size of the company's total debt and its ability to generate net income.

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