International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 2, 2020
ISSN: 1475-7192

COMPARISON OF FINANCIAL DISTRESS ANALYSIS USING THE "Z" SCORE MODIFICATION, X-SCORE, G-SCORE AND S-SCORE MODELS TO ANALYZE THE ACCURACY OF THE BANKRUPTCY PREDICTION IN THE MINING INDUSTRY PERIOD OF 2016 – 2018

Eddy Winarso[1], R. Wedi Rusmawan Kusumah[2], Eriana Kartadjumena[3], Erly Sherlita[4], Fitri Sukmawati[5]

ABSTRACT---*Coal mining companies in Indonesia have a high business risk because most of the production is exported abroad, especially in China and India. The quality of coal in Indonesia is in the low category because it only produces 5,100 to 5,100 cal / gram. With fluctuations in world prices and unstable demand resulting in fluctuations in profits resulting in disrupted company performance, thus experiencing financial distress. In this study the researchers chose a coal mining company because of the number of companies listed in the stock exchange with 24 companies and 4 of them did not announce their annual reports continuously so that the companies studied were 20 companies from 2016 to 2018 company financial statement data which were processed using the analysis model financial distress revealed by (1) Z "Altman Modification score, (2) X score from Zmijewski, (3) Model G - Score from Grover, and (4) S - score from Grover to analyze the accuracy of bankruptcy predictions.*

The results show that (1) There are differences in the Accuracy of Bankruptcy Prediction between the Modified Z "-Score Altman Model and the Springate S-Score Model for coal mining companies listed on the Stock Exchange in the 2016-2018 period. (2) There is a difference in the Accuracy of Bankruptcy Prediction between the Modified Z "-Score Altman Model and the Zmijewski X-Score on coal mining companies listed on the Stock Exchange in the 2016-2018 period. (3) There is a difference in the Accuracy of Bankruptcy Prediction between the Modified Z "-Score Altman Model and the Grover G-Score Model for coal mining companies listed on the Stock Exchange in the 2016-2018 period. (4) There is a difference in the Accuracy of Bankruptcy Prediction between the Springate S-Score Model and the Zmijewski X-Score in the coal mining companies listed on the Stock Exchange in the 2016-2018 period. (5) There is a difference in the Accuracy of Bankruptcy Prediction between the S-Score Springate Model and the Grover G-Score Model in coal mining companies listed on the Stock Exchange in the 2016-2018 period. (6)

[1]*Widyatama University*
Eddy.winarso@widyatama.ac.id

There is a difference in the Accuracy of Bankruptcy Prediction between Zmijewski's X-Score Model and Grover's G-Score Model in coal mining companies listed on the Stock Exchange in the 2016-2018 period.

Keywords---*coal, financial distress, bankruptcy, Model Z "score, Model X Score, Model G Score, Model S Score*

I. Introduction

The growth of the commodity sector in the mining sector is increasingly rapid, competition in the business world will be increasingly competitive in the provision and acquisition of information as a basis for decision makers.

Mining is different from trade, industry and agriculture. The mining business requires a longer period of time for exploration and exploitation activities, this information reflects how the mining company's financial position is different from other businesses. Many accounts must be disclosed in the financial statements.

Many factors influence the condition of the ups and downs of the mining market in Indonesia, the internal factors of the mining market originating from the issuer and external factors outside the issuer such as domestic political stability. Because this will affect the selling price, which is when the mining market is developing this shows that the economy is also experiencing an increase, this can show the issuer's performance significantly. Fluctuations in share prices in the mining sector are highly unpredictable, sometimes high, sometimes low because they are influenced by foreign and domestic factors.

Companies that are listed on the capital market (go public), are required to prepare to submit performance reports in the form of financial statements as a form of management responsibility to investors and stakeholders each period (Prastiwi et al, 2014). Investors in the capital market need reports that are reliable, relevant, easy to understand and can be compared. The information contained in it must truly describe the real performance of the company.

Financial statements are accounting data that can provide information about the performance of a company, information must be in accordance with the needs of investors for decision making.

The mining sector is broadly divided into 4 categories, namely: (1) Coal; (2) rocks; (3) Metal; and (4) Oil and Gas. In this study we emphasize on one of the four categories namely Coal.

Coal is a fossil fuel, the most important source of energy for electricity generation and a variety of functions as a staple fuel for steel and cement production. The use of coal fuel has positive and negative aspects. The negative aspect is that it causes the most pollution due to high carbon content. The positive aspect of production costs is cheaper compared to oil and natural gas sources.

In Indonesia, coal resources are distributed in: (1) South Sumatra; (2) South Kalimantan; and (3) East Kalimantan. In addition there are also in other areas such as Sulawesi and Papua, but the amount is not so large. Map of coal distribution can be seen in Figure 1

Figure 1

Coal Resources in Indonesia

Source: https://www.indonesia-investment.com/id/bisnis/komoditas/batu-bara/item236

Indonesia is the fifth coal producer after India with 255.7 million tons of oil. A list of coal producers in 2016 can be seen in table 1

Table 1: the Largest Coal Producer in 2016[1]

Country	Production Volume (equivalent to million ton of oil)
China	1685.7
United States	364.8
Australia	299.3
India	288.5
Indonesia	255.7
Russia	192.8
South Africa	142.4

[1] commercial solid fuels for example bituminous coal, anthracite (hard coal), lignite and young coal (sub-bituminous)

Source: BP Statistical Review of World Energy 2017

In a country's economy, the mining sector is one of the sectors that gives income to the state and even has a very strategic and important role, from the production of coal 80% of which is exported, in the state revenue of 85% obtained

from coal sales. Coal export destinations are to countries: China, India, Japan and South Korea. Table 2 shows data on the production, export sales, and domestic coal consumption.

Table 2: Coal Production, Exports, Consumption & Prices:

	2014	2015	2016	2017	2018	2019
Production (in million tons)	458	461	456	461	425[1]	400[1]
Export (in million tons)	382	375	365	364	311[1]	160[1]
Domestic (in million tons)	76	86	91	97	114[1]	240[1]
Price (HBA) (USD/ton)	72.6	60.1	61.8	n.a.	n.a.	n.a.

[1] projection

	2007	2008	2009	2010	2011	2012	2013
Production (in million tons)	217	240	254	275	353	412	474
Export (in million tons)	163	191	198	210	287	345	402
Domestic (in million tons)	61	49	56	65	66	67	72
Price (HBA) (USD/ton)	n.a	n.a	70.7	91.7	118.4	95.5	82.9

Source: Indonesian Coal Mining Association (APBI) & Ministry of Energy and Mineral Resources

Note: HBA = The reference coal price

By looking at the condition, coal reserves are still said to be high, namely: Global coal is estimated to run out around the next 112 years. The largest coal reserves are found in the United States, Russia, the People's Republic of China (PRC), and India.

Indonesia is one of the largest coal producers and exporters in the world. Since 2005, when it surpassed Australian production, Indonesia has been a leading exporter of thermal coal. A significant portion of the exported thermal coal consists of medium quality types (between 5100 and 6100 cal / gram) and low quality types (below 5100 cal / gram), which mostly come from China and India. Based on information provided by the Indonesian Ministry of Energy and

Mineral Resources, Indonesia's coal reserves are estimated to be exhausted in approximately 83 years if current production levels continue.

Regarding global coal reserves, Indonesia is currently ranked 9th with around 2.2 percent of the total proven global coal reserves based on the BP Statistical Review of World Energy. About 60 percent of Indonesia's total coal reserves consist of cheaper, lower-quality (sub-bituminous) coal which has a content of less than 6100 cal / gram.

The Indonesian coal industry is divided with only a few large producers and many small-scale actors owning coal mines and coal mining concessions (mainly in Sumatra and Kalimantan).

Since the early 1990s, when the coal mining sector was reopened for foreign investment, Indonesia has experienced an increase in domestic coal production, exports and sales. But domestic sales are somewhat insignificant because domestic coal consumption is relatively small in Indonesia.

However, in recent years there has been a rapid increase in domestic coal sales because the Indonesian government is committed to its ambitious energy program (implying the construction of various power plants, most of which use coal as an energy source because Indonesia has enough coal reserves). In addition, several large mining companies in Indonesia (for example Adaro Energy's coal miners) have expanded into the energy sector because low commodity prices make it unattractive to stay focused on coal exports, so that it becomes an integrated energy company that consumes their own coal.

Indonesia's coal exports range from 70 to 80 percent of total coal production, the rest is sold on the domestic market. See table 3.

The reference world coal prices (HBA) in Indonesia can be seen in table 3:

Table 3: The Reference coal Price (HBA) in Indonesia

Month	2012	2013	2014	2015	2016	2017
January	109.29	87.55	81.90	63.84	53.20	86.23
February	111.58	88.35	80.44	62.92	50.92	83.32
March	112.87	90.09	77.01	67.76	51.62	81.90
April	105.61	88.56	74.81	64.48	52.32	82.51
May	102.12	85.33	73.60	61.08	51.20	83.81
June	96.65	84.87	73.64	59.59	51.87	75.46
July	87.56	81.69	72.45	59.16	53.00	78.95
August	84.65	76.70	70.29	59.14	58.37	83.97
September	86.21	76.89	69.69	58.21	63.93	92.03
October	86.04	76.61	67.26	57.39	69.07	93.99
November	81.44	78.13	65.70	54.43	84.89	94.84

December	81.75	80.31	69.23	53.51	101.69	94.04
Average	**95.5**	**82.9**	**72.6**	**60.1**	**61.8**	**85.9**

in USD/ton

Source: Ministry of Energy and Mineral Resources

Based on table 3, it can be seen that the average reference coal price (HBA) in 2012 was the highest price, but in the following year it declined to the lowest point in 2015, following the government's policy to use domestic energy generation using fuel coal has increased since 2015 and in 2017 reached HBA 85.9.

The commodity boom in the 2000s generated significant profits for companies engaged in coal exports, because there were still very few companies operating in the coal mining sector.

The increase in coal commodity prices was largely triggered by economic growth in developing countries. However, this favorable situation changed during the 2008 global financial crisis when commodity prices declined so rapidly.

Indonesia is affected by these external factors because commodity exports (mainly for coal and palm oil) contribute around 50% of Indonesia's total exports, limiting GDP growth in 2009 to 4.6% (which is arguably still quite good, mainly supported by domestic consumption). In semester 2 of 2009 until the beginning of 2011, global coal prices experienced a sharp rebound. Nevertheless, the decline in global economic activity has reduced coal demand, causing a sharp decline in coal prices from the beginning of 2011 to the middle of 2016.

Apart from the slow pace of global economic growth (and the sharp weakening of the PRC economy), the decline in commodity demand, there are also other factors at play. During the profitable commodity boom era of the 2000s, many new mining companies were established in Indonesia while existing mining companies increased investment to expand their production capacity. This caused a huge oversupply and was exacerbated by the enthusiasm of coal miners in 2010-2013 to produce and sell as much coal as possible - due to low global coal prices - in order to generate revenue and profits.

In the second half of 2016 coal prices surged to the level we saw in early 2014, giving a fresh air to the mining industry. The price increase was triggered by the recovery in crude oil prices, increasing domestic coal demand in Indonesia in line with the return of new coal-fired power plants, but more importantly, China's coal mining policy.

China, the world's largest coal producer and consumer, decided to cut its domestic coal production day. The main reason why China wants to push coal prices to a higher level in the second half of 2016 is the high ratio of non-performing loans (NPLs) in the Chinese banking sector. The NPL ratio increased to 2.3 percent in 2015. The main reason explaining the increase in the NPL ratio is that Chinese coal mining companies are having difficulty paying their debts to banks.

However, considering that global economic activity is still rather bleak, the direction of coal prices in the short to medium term is very dependent on China's coal policy.

By looking at the fluctuating coal price in the world, it affects the financial performance of coal companies in Indonesia, namely experiencing financial difficulties in fulfilling short-term and long-term obligations so that mining companies experience financial distress.

Although global awareness has been built to reduce dependence on fossil fuels, the development of renewable energy sources does not indicate that dependence on fossil fuels (especially coal) will decrease significantly in the near future, so that coal continues to be a vital energy source. Nevertheless, clean coal technology in coal mining will be very much needed in the future (partly due to commercial factors) and Indonesia is expected to be actively involved in the process as

one of the main players in the coal mining sector. Clean coal technology is focused on reducing emissions produced by coal-fired power plants, but this technology has not developed well enough. Upstream activities related to coal mining, such as the development of coalbed methane (CBM) reservoirs whose potential is widely owned by Indonesia, have begun to receive attention lately.

Indonesian Government policies affect the national coal mining industry. To obtain domestic supply, the Indonesian Ministry of Energy and Mineral Resources asks coal producers to reserve a certain amount of production for domestic consumption (domestic market obligation). In addition, the Government can adjust its export taxes to reduce coal exports. Over the last few years the Government has expressed a desire to increase domestic coal consumption so that coal supplies about 30% of the national energy mix in 2025, this can be seen in table 4:

Table 4: Indonesian Energy Mix:

	Energy Mix 2011	Energy Mix 2025
Crude Oil	50%	23%
Coal	24%	30%
Natural gas	20%	20%
Renewable Energy	6%	26%

Source: Ministry of Energy and Mineral (ESDM)

Looking at the background above, this research will look at the financial performance of mining companies from annual reports published to predict whether the coal mining industry shows a state of financial distress or is bankrupt or remains in good condition.

Bankruptcy is characterized by stopping the company's operations in the long run and not having the ability to rehabilitate operational activities. This can happen, we can examine coal mining.

Failures can be analyzed with the Altman Z-Score bankruptcy prediction model, Zmijewski X-Score bankruptcy prediction model, the Grover G-Score bankruptcy prediction model, and the S-Score Springate bankruptcy prediction model.

The Altman Z-Score bankruptcy prediction model uses four indicators of financial ratios that can be combined to see the difference between bankrupt and non-bankrupt companies, namely Working Capital to Total Assets, Retained Earnings to Total Assets, Earnings before Interest and Taxes to Total Assets, Market Value of Equity to Book Value of total Liabilities.

Zmijewski's X-Score Bankruptcy Model uses a combination of indicators of financial ratios, namely: Return on Assets, Debt Ratio, and Current Ratio.

The Grover G-Score Bankruptcy Prediction Model uses a combination of financial ratio indicators, namely: Working capital to Total assets, Earnings before interest and taxes to Total assets, net income to total assets.

The Springate S-Score Bankruptcy Model uses a combination of indicators of financial ratios namely; Working capital to total assets, Net profit before interest and taxes to total assets, Net profit before taxes to current liability, Sales to total assets.

The method of bankruptcy calculation is based on circumstances where the company does not have the financial capacity to meet short-term and long-term obligations due to operational failure. (Acep, 2018: 479)

Previous research

Bankruptcy research has been studied by Ni Made Evi Dwi Prihanthini, and Maria M. Ratna Sari (2013) at the Food And Beverage Company on the Indonesia Stock Exchange using the Grover, Altman Z-Score, Springate and Zmijewski bankruptcy prediction models, the results of the study showed significant differences between the Grover model with the Altman Z-Score model, the Grover model with the Springate model, as well as the Grover model with the Zmijewski model and the highest level of accuracy achieved by the Grover model then followed by the Springate model, the Zmijewski model, and finally the Altman Z-score model.

Queenaria Jayanti, Rustiana (2015) by establishing companies based on financial health criteria as prediction of voluntary auditor switching or gray areas into non-bankrupt and non-bankrupt companies by matching the results of bankruptcy index calculations with the occurrence of voluntary Public Accounting Firms (KAP) through the name of KAP contained in the Indonesia Capital Directory (ICMD).

Bankruptcy Research is widely researched by experts by using various models including in conducting their research they use financial ratios as an element. Firda Mastuti et al (2013) in their study using the Altman Z-Score method for 5 samples of plastic and packaging companies listed on the IDX are 1 company stated in bankruptcy estimation, 2 companies out of which 10 are stated in vulnerable conditions, and the remaining 2 companies are stated in healthy conditions .

Hudah and Lina Siti Nuril (2011), conducted research using bankruptcy prediction models, namely the Modified Altman Model, Z-Scoore Springate, Zmijewski, and Ohlson.

Based on the results of the Altman Z-Score Modification model, there are no companies that are predicted to go bankrupt, but there are 2 companies that experience gray areas. There are 3 Springate model companies that are predicted to go bankrupt, while 10 other companies are predicted not to go bankrupt. In the Zmijewski Model, all companies are predicted not to go bankrupt. Whereas in the Ohlson model there are 6 bankrupt companies and 7 other companies are predicted not to go bankrupt (Hussain et al., 2019).

Based on the phenomena that occur, the authors are interested in conducting research on bankruptcy predictions on coal mining companies listed on the Indonesia Stock Exchange (IDX), using 4 prediction methods where the prediction method is a method that combines variables from several financial ratios. The methods used are; Modified Z ”-Score Altman Model, Zmijewski X-Score Model, Grover G-Score Model, and Springate S-Score Model.

The research title is as follows:

COMPARISON OF FINANCIAL DISTRESS ANALYSIS USING Z ”SCORE MODIFICATION, X-SCORE, G-SCORE AND S-SCORE MODELS TO ANALYZE THE ACCURACY OF BANKRUPTCY PREDICTION IN THE MINING INDUSTRY
PERIOD OF 2016 – 2018

Theoretical basis

Model Z ”Altman -Score Modification

To predict financial distress developed by Edward I, known as Altman’s Z-Score. Alman's score uses multiple ratios to predict financial disress, namely: X_1 = woking capital to Total Assets, X_2 = Retained Earnings to Total Assets, X_3 =

Earnings before interest and taxes to total assets, X_4 = Shareholders' equity to total liabilities, and X_5 Sales to total assets so the Altman Z-score is:

$$Z = 0.717\ X_1 + 0.847\ X_2 + 3.107\ X_3 + 0.420\ X_4 + 0.998\ X_5$$

Altman modified the model in 1995 by minimizing industrial effects due to the presence of asset turnover variable (X_5). The model has been modified by eliminating the variable asset turnover, then the model can be used to measure bankruptcy in all companies both manufacturing companies and non-manufacturing companies. The Altman Z Score Model is modified as follows:

$$Z\text{ ”-Score} = 6,56\ (X_1) + 3,26\ (X_2) + 6,72\ (X_3) + 1,05\ (X_4)$$

Information:

X_1 = (Working Capital / Total Assets)

X_2 = (Retained Earnings / Total Assets)

X_3 = (Earnings before Interest and Taxes / Total Assets)

X_4 = (Market Value of Equity / Total Assets)

Based on the Modified Z value model -Score analysis is divided into three categories as follows:

1) If the value of Z "> 2, 60, the company is included in the healthy category.
2) If the value of 1, 10 <Z "<2, 60 then the company is included in the category of gray area (can not be determined whether the company is healthy or unhealthy).
3) If the value of Z "<1, 10, the company is included in the unhealthy category. (Acep, 2018: 482).

Zmijewski X-Score Model

Zmijewski's X-Score model uses the ratio: Return on Assets, leverage ratio, current Asset ratio as predictors of bankruptcy as measured by X-Score using multiple regression analysis. Models as follows:

$$\text{X-Score} = -4.3 - 4.5\ (X_1) + 5.7\ 9\ (X_2) - 0.004\ (X_3)$$

Information:

X_1 = ROA (Net Income / Total Assets)

X_2 = (Debt / Total Assets)

X_3 = (Current Asset / Current Liabilities)

The conditions for calculating the Zmijewski model are as follows:

1) If the X-score is negative (X-Score <0), then the company is in a healthy condition.
2) If the X-score is positive (X-Score ≥ 0), then the company is in an unhealthy condition or tends to lead to potential bankruptcy. (Acep, 2018: 480)

Grover G-Score Model

The Grover model is a model aimed at reassessing the Altman Z-Score model. Jeffrey S. Grover used the same sample as the Altman Z-score model in 1968 by adding 13 new financial ratios. The samples used were 70 companies with a condition of 35 bankruptcy and 35 companies that did not go bankrupt. Models as follows:

$$\text{G-Score} = 1,650\ (X_1) + 3,404\ (X_2) - 0,016\ (X_3) + 0,057$$

Information:

X_1 = (Working Capital / Total Assets)

X_2 = (Earnings before Interest and Taxes / Total Assets)

X_3 = (Net Income / Total Assets)

The following conditions:

1) Companies in a state of bankruptcy show scores less or equal to - 0, 02 (G ≤ -0, 02).
2) Companies in a state of bankruptcy show more value or equal to 0, 01 (G ≥ 0, 01).
3) The company is in the score between the upper limit and the lower limit is in the gray area. (Acep, 2018: 481)

Springate S-Score Model

The Springate bankruptcy prediction model uses the same analytical method as Altman, using Multiple Discriminant Analysis (MDA). Initially the S-Score model consisted of 19 popular financial ratios, but after testing the same as that of Altman, Springate determined 4 ratios with the assumption that it could distinguish companies that went bankrupt and those that did not go bankrupt. Models as follows:

$$S\text{-Score} = 1, 03\ (X_1) + 3, 07\ (X_2) + 0, 66\ (X_3) + 0, 4\ (X_4)$$

Information:

X_1 = (Working Capital / Total Assets)

X_2 = (Net Profit before Interest and Taxes / Total Assets)

X_3 = (Net Profit before Taxes / Current Liability)

X_4 = (Sales / total assets)

Bankruptcy provisions are as follows:

1) If the S-Score score is less than 0.862 (S <0.862) the company is classified as bankrupt
2) If the S-Score is more or equal to 0.862 (S ≥ 0.862), it is classified as a sound financial company. (Acep Edison, 2018: 481).

Conceptual paradigm of research

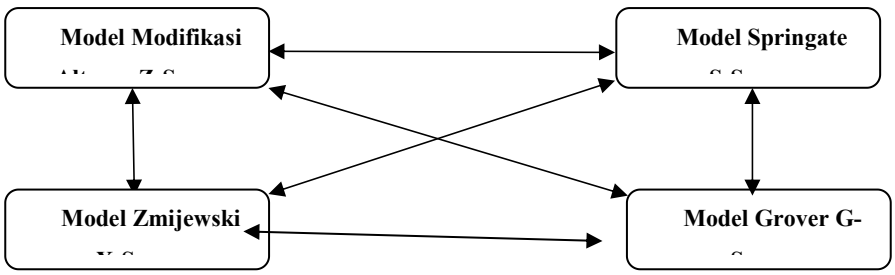

Figure 2: Conceptual paradigm of research

Hypotesis

H_1: Difference Between the Accuracy of Bankruptcy Prediction between the Modified Z ”-Score Altman Model and the Springate S-Score Model.

H_2: The Difference Between the Accuracy of Bankruptcy Prediction between the Modified Z ”-Score Altman Model and the Zmijewski X-Score

H_3: Difference in Accuracy of Bankruptcy Prediction between Modified Z ”-Score Altman Model and Grover's G-Score Model

H_4: The Difference Between the Accuracy of Bankruptcy Prediction between the Springate S-Score Model and the Zmijewski X-Score.

H_5: The Difference Between the Accuracy of Bankruptcy Prediction between the Springate S-Score Model and the Grover G-Score Model.

H_6: Differences in Accuracy in Bankruptcy Prediction between Zmijewski's X-Score Model and Grover's G-Score Model.

2.6 Research methods

The study population is the annual financial statements of coal mining sector companies of 24 (twenty four) listed on the Indonesia Stock Exchange as follows:

Table 5: List of Coal Mining Companies listed on the Indonesia Stock Exchange

No	Issuer Code	The Name of the Issuer
1	ADRO	PT Adaro Energi, Tbk
2	ARII	PT Atlas Resources, Tbk
3	ATPK	PT Bara Jaya Internasional, Tbk
4	BORN	PT Borneo Lumbung Energi dan Metal, Tbk
5	BSSR	PT Baramulit Sukses Sarana, Tbk
6	BUMI	PT Bumi Resources, Tbk
7	BYAN	PT Bayan Resources, Tbk
8	DEWA	PT Derma Henwa, Tbk
9	DOID	PT Delta Dunia Makmur, Tbk
10	DSSA	PT Dian Swastika Sentosa, Tbk
11	FIRE	PT Alfa Energi Investama, Tbk
12	GEMS	PT Golden Energy Mines, Tbk
13	GTBO	PT Garda Tujuh Buana, Tbk
14	HRUM	PT Harum Energy, Tbk
15	INDY	PT Indika Energy, Tbk

16	ITMG	PT Indo Tambang Raya Megah, Tbk
17	KKGI	PT Resource Alam Indonesia, Tbk
18	MBAP	PT Mitrabara Adiperdana, Tbk
19	MYOH	PT Samindo Resources, Tbk
20	PKPK	PT Perdana Karya Perkasa, Tbk
21	PTBA	PT Bukit Asam, Tbk
22	PTRO	PT Petrosea, Tbk
23	SMMT	PT Golden Eagle Energy, Tbk
24	TOBA	PT Toba Bara Sejahtera, Tbk

Source: IDX.co.id

Of the 24 listed companies, 4 companies do not provide complete financial reports, namely BORN, DSSA, GTBO and INDY which are incomplete so that there are 20 coal mining company financial statements that can be examined for 2016 to 2018. List of coal company samples used in this research:

Table 6: List of Coal Mining Company Samples

No	Issuer Code	The Name of the Issuer
1	ADRO	PT Adaro Energi, Tbk
2	ARII	PT Atlas Resources, Tbk
3	ATPK	PT Bara Jaya Internasional, Tbk
4	BSSR	PT Baramulit Sukses Sarana, Tbk
5	BUMI	PT Bumi Resources, Tbk
6	BYAN	PT Bayan Resources, Tbk
7	DEWA	PT Derma Henwa, Tbk
8	DOID	PT Delta Dunia Makmur, Tbk
9	FIRE	PT Alfa Energi Investama, Tbk
10	GEMS	PT Golden Energy Mines, Tbk
11	HRUM	PT Harum Energy, Tbk
12	ITMG	PT Indo Tambang Raya Megah, Tbk

13	KKGI	PT Resource Alam Indonesia, Tbk
14	MBAP	PT Mitrabara Adiperdana, Tbk
15	MYOH	PT Samindo Resources, Tbk
16	PKPK	PT Perdana Karya Perkasa, Tbk
17	PTBA	PT Bukit Asam, Tbk
18	PTRO	PT Petrosea, Tbk
19	SMMT	PT Golden Eagle Energy, Tbk
20	TOBA	PT Toba Bara Sejahtera, Tbk

Source: IDX.co.id

Operationalization Variable

Tabel 7: Operationalization of Variables

Variable	Dimension	Indicator	Scale
Model Z"-Score Altman Modification,	• Working Capital • Current Asset • Net Profit • EBIT • Total Asset • Equity	• $X_1 = \frac{\text{Working Capital}}{\text{Total Assets}}$ • $X_2 = \frac{\text{Retained Earnings}}{\text{Total Assets}}$ • $X_3 = \frac{\text{Earnings Before I And T}}{\text{Total Assets}}$ • $X_4 = \frac{\text{Market Value Of Equity}}{\text{Total Assets}}$	Rasio
Model X-Score Zmijewski,	Total Asset Current Asset Current Liabilities	$X_1 = \frac{\text{Net Income}}{\text{Total Asset}}$ $X_2 = \frac{\text{Debt}}{\text{Total Asset}}$ $X_3 = \frac{\text{Current Liabilities}}{\text{Current Asset}}$	Rasio
Model G-Score Grover,	• Working Capital • Current Asset • Net Profit	$X_1 = \frac{\text{Working Capital}}{\text{Total Assets}}/$ $X_2 = \frac{\text{Earnings Before Interst And Taxs}}{\text{Total Assets}}$ $X_3 = \frac{\text{Net Income}}{\text{Total Asset}}$	Rasio

Variable	Dimension	Indicator	Scale
	• EBIT • Total Asset		
Model S-Score Springate.	• Working Capital • EBIT • Total Asset • Sales	$X_1 = \frac{\text{Working Capital}}{\text{Total Assets}}$ $X_2 = \frac{\text{Earnings Before Interst And Taxs}}{\text{Total Assets}}$ $X_3 = \frac{\text{Earnings Before Interst And Taxs}}{\text{Current Liabilities}}$ $X_4 = \frac{\text{Sales}}{\text{Total Asset}}$	Rasio

II. Research result

Bankruptcy Analysis

Bankruptcy analysis is done by calculating the value of each of the predefined bankruptcy models. Analysis as follows:

Bankruptcy Analysis using the Altman Modified Z ”Z model

Calculation results are as follows:

Table 8: Calculation results with the Z ”-Score Altman Modification Bankruptcy Prediction model

		Z Score	2016		Z Score	2017		Z Score	2018	
ADRO		8,76975	Healthy	1	7,94724	Healthy	1	7,26412	Healthy	1
ARII		0,33899	Not healthy	3	5,52016	Helathy	1	3,04366	Helathy	1
ATPK		(0,47754)	Not healthy	3	(3,74717)	Not healthy	3	(3,78763)	Not healthy	3
BSSR		2,51638	Gray	2	5,59342	Healthy	1	4,07490	Healthy	1
BUMI		(6,80066)	Not healthy	3	(3,39230)	Not helathy	3	(3,28972)	Not healthy	3
BYAN		0,84641	Not healthy	3	3,97487	Healthy	1	6,20581	Healthy	1

DEWA		1,21124	Gray	2	0,89199	Not healthy	3	0,76699	Not healthy	3
DOID		1,32832	Gray	2	2,08593	Gray	2	2,42963	Gray	2
FIRE		0,88934	Not Healthy	3	3,35003	Healthy	1	2,22224	Healthy	1
GEMS		3,89600	Healthy	1	4,20075	Healthy	1	2,51069	Gray	2
HRUM		5,07706	Healthy	1	6,15803	Healthy	1	5,35261	Healthy	1
ITMG		19,40448	Healthy	1	23,74804	Healthy	1	23,68282	Healthy	1
KKGI		3,35717	Healthy	1	6,52188	Healthy	1	3,70188	Healthy	1
MBAP		9,52528	Healthy	1	10,76692	Healthy	1	9,34855	Healthy	1
MYOH		5,80513	Healthy	1	5,13291	Healthy	1	6,75046	Healthy	1
PKPK		(2,84890)	Not healthy	3	(0,32024)	Not healthy	3	0,44608	Not healthy	3
PTBA		5,77927	Healthy	1	7,34812	Healthy	1	7,98926	Healthy	1
PTRO		4,24752	Healthy	1	6,22613	Healthy	1	5,98442	Healthy	1
SMMT		1,54332	Gray	2	1,78477	Gray	2	2,66096	Sehat	1
TOBA		1,07957	Not healthy	3	2,36310	Gray	2	2,27084	Gray	2

Source: Annual Report Company IDX.co.id (processed)

Table 9: Recapitulation Z" Score Altaman Modification

Information	code	2016	2017	2018

Healthy	1	9	13	13
Gray	2	4	3	4
Not Healthy	3	7	4	3
Total		20	20	20

Source: Data Exel (processed)

Analysis:

Based on the Z ”Altman Modification Score in table 9 companies that are categorized as healthy in 2018 are 13 companies or 65%, Gray area is 4 companies or 20%, and unhealthy are 3 companies or 15%. Analysis from 2016 to 2018 was obtained according to the Model Z "Altman Score Modified ARII, BYAN, FIRE in 2016 was not healthy then in 2017 and 2018 became healthy. Whereas ATPK, BUMI, and BSSR from the gray area in 2016 became healthy in 2017 and 2018.

DEWA from the gray area in 2016 dropped to unhealthy in 2017 and 2018. DOID and FIRE remained in the gray area, and PKPK remained unhealthy, while SMMT from the gray area in 2016 and 2017 became healthy in 2018. TOBA from unhealthy has increased its status to gray area in 2017 and 2018.

Bankruptcy Analysis using X – Score Model Zmijewski calculation results are as follows:

Table 10: Calculation results with Zmijewski's X-Score Bankruptcy Prediction model

		X Score	2016		X Score	2017		X Score	2018	
ADRO		(2,11578)	Healthy	1	(2,35116)	Healthy	1	(2,35051)	Healthy	1
ARII		0,84977	Not healthy	3	1,01511	Not heatlhy	3	1,68715	Not healthy	3
ATPK		(0,38682)	Healthy	1	0,58619	Not healthy	3	0,39698	Not healthy	3
BSSR		(3,19276)	Healthy	1	(4,41928)	healthy	1	(3,33290)	Healthy	1
BUMI		6,51035	Not Healthy	3	0,74369	Not healthy	3	0,55979	Not Healthy	3
BYAN		0,06053	Not healthy	3	(3,58426)	Healthy	1	(3,97643)	Healthy	1
DEWA		(1,93881)	Healthy	1	(1,82342)	Healthy	1	(1,76036)	Healthy	1
DOID		0,46541	Not healthy	3	0,17634	Not healthy	3	(0,08255)	Healthy	1

FIRE		0,02842	Not healthy	3	(1,35196)	Healthy	1	(1,75646)	Healthy	1
GEMS		(3,00341)	Healthy	1	(2,29748)	Healthy	1	(1,76902)	Healthy	1
HRUM		(3,70450)	Healthy	1	(4,06749)	Healthy	1	(3,72123)	Healthy	1
ITMG		(3,34813)	Healthy	1	(3,43986)	Healthy	1	(3,21691)	Healthy	1
KKGI		(3,90931)	Healthy	1	(3,98413)	Healthy	1	(2,81533)	Healthy	1
MBAP		(4,13092)	Healthy	1	(4,56823)	Healthy	1	(3,96930)	Healthy	1
MYOH		(3,40299)	Healthy	1	(3,29174)	Healthy	1	(3,80500)	Healthy	1
PKPK		(0,68490)	Healthy	1	(0,72327)	Healthy	1	(1,33664)	Healthy	1
PTBA		(2,29598)	Healthy	1	(3,08447)	Healthy	1	(3,36984)	Healthy	1
PTRO		(0,93761)	Healthy	1	(1,04177)	Healthy	1	(0,69625)	Healthy	1
SMMT		(1,84811)	Healthy	1	(2,10542)	Healthy	1	(2,37570)	Healthy	1
TOBA		(2,03498)	Healthy	1	(1,95602)	Healthy	1	(1,61296)	Healthy	1

Source: Annual Report Company IDX.co.id (processed)

Table 11: Recapitulation X Score Zmijewski

Information	Code	2016	2017	2018
Healty	1	15	16	17
Gray	2	0	0	0
Not Healthy	3	5	4	3

Total		20	20	20

Source: Data Exel (processed)

Analysis:

Based on table 11, Zmijewski's Model X Score is in the healthy category in 2018 with 17 companies or 85% of the gray area is missing because according to the X Score it only classifies into 2 categories that are healthy or unhealthy while the remaining 3 companies are included in the unhealthy category.

Based on table 10 it can be seen that ATPK in 2016 was healthy then in 2017 and 2018 it fell unhealthy, while BYAN and FIRE from unhealthy in 2016 became healthy in 2017 and 2018.

DOID is not healthy in 2016 and 2017 becomes healthy in 2018, which has not changed. ARII remains at an unhealthy low point.

Bankruptcy Analysis using G – Score Model Grover

Calculation results are as follows:

Table 12: Calculation results with the Grover G-Score Bankruptcy Prediction model

		G Score	2016		G Score	2017		G score	2018	
ADRO		0,60736	Healthy	1	0,83855	Healthy	1	0,66627	Healthy	1
ARII		(0,93990)	Not Healthy	3	(0,66916)	Not healthy	3	(0,97692)	Not healthy	3
ATPK		(0,61847)	Not healthy	3	(0,69208)	Not Healthy	3	(0,76134)	Not healthy	3
BSSR		0,78329	Healthy	1	2,06279	Healthy	1	1,46446	Healthy	1
BUMI		0,20064	Healthy	1	0,27521	Healthy	1	0,04239	Healthy	1
BYAN		0,63974	Healthy	1	1,78420	Healthy	1	2,25830	Healthy	1
DEWA		0,14654	Healthy	1	0,10338	Healthy	1	0,03763	Healthy	1
DOID		0,64654	Healthy	1	0,77962	Healthy	1	0,75097	Healthy	1
FIRE		0,27022	Healthy	1	0,62043	Healthy	1	0,23256	Healthy	1

GEMS		1,23918	Healthy	1	1,54815	Healthy	1	0,95525	Healthy	1
HRUM		1,17047	Healthy	1	1,53981	Healthy	1	1,27725	Healthy	1
ITMG		1,00744	Healthy	1	1,53326	Healthy	1	1,35459	Healthy	1
KKGI		1,06571	Healthy	1	1,14978	Healthy	1	0,22781	Healthy	1
MBAP		1,87647	Healthy	1	2,48491	Healthy	1	2,02454	Healthy	1
MYOH		1,47945	Healthy	1	1,17149	Healthy	1	1,79224	Healthy	1
PKPK		(0,48065)	Gray	2	0,15175	Healthy	1	0,53959	Healthy	1
PTBA		0,87721	Halthy	1	1,50998	Healthy	1	1,49834	Healthy	1
PTRO		0,39608	Healthy	1	0,51473	Healthy	1	0,64484	Healthy	1
SMMT		(0,15957)	Not Healthy	3	0,08825	Healthy	1	0,23144	Healthy	1
TOBA		0,44913	Healthy	1	0,86621	Healthy	1	0,86986	Healthy	1

Source: Annual Report Company IDX.co.id (processed)

Table 13: Recapitulation G Score Grover

Information	Code	2016	2017	2018
Healty	1	16	18	18
Gray	2	1	0	0
Not Healthy	3	3	2	2
Total		20	20	20

Source: Data Exel (processed)

Analysis:

Based on the table 13 models of the G Score Grover companies are categorized as healthy in 2018 as many as 18 companies or 90% while the remaining 10% are categorized as unhealthy. Analysis from 2016 to 2018 obtained ARII and ATPK throughout the observation year remained in unhealthy areas while PKPK from gray areas in 2016 became healthy in 2017 and 2018 and SMMT from from unhealthy in 2016 to healthy in 2017 and 2018.

Bankruptcy Analysis using S – Score Model Springate

Calculation results are as follows:

Table 14: Calculation results with the Springate S-Score Bankruptcy Prediction model

		S Score	2016		S Score	2017		S Score	2018	
ADRO		15,96862	Healthy	1	19,65458	Healthy	1	12,68858	healthy	1
ARII		(52,99466)	Not Healthy	3	(43,13700)	Not healthy	3	(51,71877)	Not Healthy	3
ATPK		(6,05093)	Not Healthy	3	(19,26720)	Not healthy	3	(19,74273)	Not Healthy	3
BSSR		4,58229	Healthy	1	15,72372	Healthy	1	9,45323	Healthy	1
BUMI		(7,56868)	Not Healthy	3	(15,41346)	Not healthy	3	(17,94268)	Not healthy	3
BYAN		17,76054	Healthy	1	3,79433	Healthy	1	12,04452	Healthy	1
DEWA		1,28086	Healthy	1	(5,52996)	Not healthy	3	(6,58578)	Not healthy	3
DOID		10,19471	Healthy	1	15,04574	Healthy	1	15,14963	Healthy	1
FIRE		1,75322	Healthy	1	29,84375	Healthy	1	8,01100	Healthy	1
GEMS		42,26162	Healthy	1	31,23150	Healthy	1	13,25937	Healthy	1
HRUM		54,43921	Healthy	1	59,81648	Healthy	1	54,48054	Healthy	1
ITMG		27,02818	Healthy	1	37,63871	Healthy	1	28,84601	Healthy	1

KKGI		32,89767	Healthy	1	30,32828	Healthy	1	8,55301	Healthy	1
MBAP		50,00219	Healthy	1	51,21833	Healthy	1	42,64548	Healthy	1
MYOH		47,26131	Helathy	1	43,52164	Healthy	1	52,17832	Healthy	1
PKPK		(17,03160)	Not Healthy	3	24,67767	Healthy	1	29,01027	Healthy	1
PTBA		19,47376	Healthy	1	33,05167	Healthy	1	31,14156	Healthy	1
PTRO		20,89307	Healthy	1	17,47372	Healthy	1	19,71320	Helathy	1
SMMT		(9,85905)	Not helathy	3	(12,99399)	Not healthy	3	(13,83954)	Not healthy	3
TOBA		0,07354	Not healthy	3	11,76767	Healthy	1	6,89364	Healthy	1

Source: Annual Report Company IDX.co.id (processed)

Table 15: Recapitulation S Score Springate

Information	Code	2016	2017	2018
Healthy	1	14	15	15
Gray	2	0	0	0
Not Healthy	3	6	5	5
Total		20	20	20

Source: Data Exel (processed)

Analysis:

Based on table 15 the S Score Springate model obtained companies in the healthy category of 15 companies or 75% and the remaining 5 companies by 25% the unhealthy category.

Analysis from 2016 to 2018 obtained by DEWA in 2016, healthy in 2017 and 2018 actually dropped to unhealthy, as ARII, ATPK, BUMI and SMMT continued to be unhealthy three years in a row. PKPK from unhealthy to healthy.

Comparison of Bankruptcy Prediction Models

Table 16: Comparison of the 2016-2018 Bankruptcy Prediction Model

Model	NUMBER OF COMPANIES								
	HEALTH			GRAY AREA			NOT HEALTHY		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Z" Score Altman Modification	9	13	13	4	3	4	7	4	3
X Score Zmijewski	15	16	17	0	0	0	5	4	3
G Score Grover	16	18	18	1	0	0	3	2	2
S Score Springate	14	15	15	0	0	0	6	5	5

Source: data processed

Based on table 16 there are some differences in the results of bankruptcy predictions between each model used, the number of companies that are in the healthy category for Model Z "-Score Altman Modification, 9 companies in 2016 increased to 13 companies in 2017 and 2018, for Model X -Score Zmijewski has increased by one company each year, 15 companies in 2016. 16 companies in 2017 and 17 companies in 2018, for the Grover G-Score Model, 16 companies in 2016 and 18 companies in 2017 and 2018, for The Springate S-Score Model is 14 companies in 2016 and 15 companies in 2017 and 2018.

The Gray Area category is only found in the Model Z "-Score Altman Modification which is 4 companies in 2016 and 3 companies in 2017, then increased again to 4 companies in 2018. And the Grover G-Score Model is 1 company in 2016, for Zmijewski X-Score Model, and Springate S-Score Model there are no companies in the Gray Area category.

The number of companies that are in the Unhealthy category for the Model Z "-Score Altman Modification is 7 companies in 2016 and dropped to 4 companies in 2017 and 3 companies in 2018, for the X-Score Model Zmijewski namely 5 companies in 2016 and fell to 4 and 3 companies in 2017 and 2018. For the Grover G-Score Model, 3 companies in 2016 and 2 companies in 2017 and 2018, for the Springate S-Score Model, 6 companies in 2016 and 5 companies in 2017 and 2018.

III. Discussion

H_1 Differences in Accuracy in Bankruptcy Prediction between the Modified Z "-Score Altman Model and the Springate S-Score Model.

Based on the results of hypothesis testing that there are differences in the accuracy of bankruptcy prediction between the Z "-Score Altman Modification Model and the Springate S-Score Model, the study found that bankruptcy prediction with

the Z" -Score Altman Modification model has more companies in the bankruptcy category compared to bankruptcy predictions the Springate S-Score model, thus the use of the S-Score Springate bankruptcy prediction model is more accurate than the Z "-Score Altman Modification bankruptcy prediction.

The solution for the bankruptcy model should be that companies use the S-Score Springate prediction of bankruptcy compared to the Z "-Score Altman Modified model.

The results of the study are the same as Hudah and Lina Siti Nuril's research in 2011 with the title Comparative analysis of the prediction of the Altman model of Z-Scoore Springate, Zmijewski, and Ohlson modification in manufacturing companies listed in self-100.

H_2 Difference Between the Accuracy of Bankruptcy Prediction between the Modified Z "-Score Altman Model and the Zmijewski X-Score

Based on the results of hypothesis testing that there are differences in the accuracy of bankruptcy prediction between the Model Z "-Score Altman Modification and the X-Score Zmijewski Model, the study found that the prediction of bankruptcy with the Z" model -Score Altman Modified more companies included in the unhealthy category (bankrupt) compared to Zmijewski's X-Score bankruptcy prediction model, thus the use of the Z "-man Altman bankruptcy reduction prediction model is more accurate than Zmijewski's X-Score bankruptcy prediction model.

The bankruptcy model solution should use the Z "-Score Altman Modification bankruptcy prediction model compared to the Zmijewski X-Score model.

The results of the study are the same as the Detiana and Dinda Antika research in 2012 with the title Analysis of Altman modification of the Z-Scoore, Springate, Zmijewski and Ohlson models on automotive companies that went public on the Indonesia Stock Exchange (BEI) which obtained the results of the Altman Modified Z-Score model there are 1 companies that are categorized as bankrupt, there are 4 companies that are categorized as vulnerable, and 1 company that is categorized as healthy.

H_3 Differences in the Accuracy of Bankruptcy Prediction between the Modified Z "-Score Altman Model and the Grover G-Score Model

Based on the results of hypothesis testing that there are differences in the accuracy of bankruptcy prediction between the Z "-Score Altman Modification Model and the Grover G-Score Model, the study found that bankruptcy prediction with the Z" -Score Altman Modification model has more companies in the bankruptcy category compared to bankruptcy predictions the G-Score Grover model, thus the use of the Z "-Score Altman bankruptcy reduction model Modification is more accurate than the G-Score Grover bankruptcy prediction model.

The solution to the bankruptcy model should be that companies use the bankruptcy prediction of the Z "-Score Altman Modification model compared to the Grover G-Score model.

H_4 Difference Between Accuracy in Bankruptcy Prediction between the Springate S-Score Model and the Zmijewski X-Score.

Based on the results of hypothesis testing there is no difference in the Accuracy of Bankruptcy Prediction between the S-Score Springate Model and the Zmijewski X-Score Model, the study found that the bankruptcy prediction with the S-Score Springate model is relatively similar compared to the prediction of the Zmijewski X-Score bankruptcy model, according to the use of the reducing model The Springate S-Score bankruptcy is the same compared to Zmijewski's X-Score bankruptcy prediction model.

The results of the study are the same as those of Peyman Imanzadeh, et al in 2011 with the title A Study of the Application of Springate and Zmijewski Bankruptcy Prediction Models in Firms Accepted in Tehran Stock Exchange which obtained the results that the Springate model is more conservative than the Zmijewski model in predicting bankruptcy.

H_5 Differences in Accuracy in Bankruptcy Prediction between the S-Score Springate Model and the Grover G-Score Model.

Based on the results of hypothesis testing that there are differences in the accuracy of bankruptcy prediction between the S-Score Springate Model and the Grover G-Score Model, the study found that the bankruptcy prediction with the S-Score Springate model more companies are included in the bankrupt category compared to the bankruptcy prediction of the G-Score model Grover, thus the use of the Springate S-Score bankruptcy prediction model is more accurate than the Grover G-Score bankruptcy prediction model.

The solution to the bankruptcy model should be that companies use the S-Score Springate bankruptcy prediction model compared to the Grover G-Score model.

H_6 Differences in Accuracy of Bankruptcy Prediction between Zmijewski's X-Score Model and Grover's G-Score Model.

Based on the results of hypothesis testing that there are differences in the accuracy of bankruptcy prediction between the Zmijewski X-Score Model and the Grover G-Score Model, the study found that bankruptcy predictions with the Zmijewski X-Score model were more companies included in the bankruptcy category than the G-Score bankruptcy prediction model. Grover, thus the use of the Zmijewski X-Score bankruptcy prediction model is more accurate than the Grover G-Score bankruptcy prediction model.

The solution to the bankruptcy model should be that companies use Zmijewski's X-Score bankruptcy prediction model compared to Grover's G-Score model.

IV. Conclusion and Suggestion

Conclution

Based on the results of the discussion the following conclusions:

1. There is a difference in the Accuracy of Bankruptcy Prediction between the Modified Z ”-Score Altman Model and the Springate S-Score Model in coal mining companies listed on the Stock Exchange in the 2016-2018 period.
2. There is a difference in the Accuracy of Bankruptcy Prediction between the Modified Z ”-Score Altman Model and the Zmijewski X-Score on coal mining companies listed on the Stock Exchange in the 2016-2018 period.
3. There are differences in the Accuracy of Bankruptcy Prediction between the Model Z ”Altman-Modified VSS with the Grover G-Score Model in coal mining companies listed on the Stock Exchange in the 2016-2018 period
4. There is a difference in the Accuracy of Bankruptcy Prediction between the S-Score Springate Model and the Zmijewski X-Score in the coal mining companies listed on the Stock Exchange in the 2016-2018 period.
5. There is a difference in the Accuracy of Bankruptcy Prediction between the S-Score Springate Model and the Grover G-Score Model for coal mining companies listed on the Indonesia Stock Exchange in the 2016-2018 period.

6. There is a difference in the Accuracy of Bankruptcy Prediction between Zmijewski's X-Score Model and Grover's G-Score Model in coal mining companies registered in the period of 2016-2018

Suggestion

Based on the conclusions that have been stated, the authors provide input or suggestions regarding the results of research that has been carried out, namely as follows:

For companies, in order to get out of the category of not healthy (bankrupt) it is recommended to improve performance on the elements of financial statements such as Working Capital, Net Income, Sales, as well as solvency ratios, and profitability ratios.

For IDX, it can make monitoring activities so that it is known which company has an indication of bankruptcy, and can provide guidance to companies that have an indication of bankruptcy.

For the next researcher, sample selection can be done in the industry sector that is prone to bankruptcy, for example, retail, which now has heavy competition, namely online or electronic business, etc.

Can use other bankruptcy prediction models such as ohlson etc., or can also create a new bankruptcy prediction model that is suitable for use in Indonesia, especially for small businesses of MSME

REFERENCES

[1] Abolfazl Aminian, dkk. 2016. Investigate the Ability of Bankruptcy Prediction Models of Altman and Springate and Zmijewski and Grover in Tehran Stock Exchange Mediterranean Journal of Social Sciences MCSER Publishing, Rome-Italy Vol 7 No 4 S1 July 2016.
[2] Acep Edison. 2018. Akuntansi Manajemen Edisi 2. Cendra: Bandung.
[3] Acep Edison. 2018. Metode Penelitian Edisi 2. Cendra: Bandung.
[4] Ayu Suci Ramadhani, Niki Lukviarman 2009. Perbandingan Analisis Prediksi Kebangkrutan Menggunakan Model Altman pertama, *Altman* revisi, dan *Altman* modifikasi dengan Ukuran dan Umur Perusahaan Sebagai Variabel Penjelas. Jurnal Siasat Bisnis. Hal: 15-28
[5] Bringham F, Eugene dan Joel F. Houston. 2014. Essentials of Financial Management, Third edition. Australia: CENGAGE
[6] Cooper, Donald R., dan Pamela S. Schindler. 2014. Business Research Methods. 12. New York: The McGraw-Hill Companies, Inc.
[7] Danang, Sunyoto. 2013. Analisis Laporan Keuangan untuk Bisnis. Yogyakarta: Caps
[8] Darsono & Ashari. 2005. Pedoman Praktis Memahami Laporan Keuangan, Yogyakarta: Andi.
[9] Detiana dan Dinda Antika, 2012. Analisis kebangkrutan model *Altman* modifikasi *Z-Scoore*, *Springate, Zmijewski* dan *Ohlson* pada perusahaan otomotif yang *Go Public* di Bursa Efek Indonesia (BEI)
[10] Diah Isti Ridha Buari. 2017. Analisis Tingkat Kebangkrutan Pada Perusahaan Manufaktur di Bursa Efek Indonesia (Studi Pada Perusahaan Yang Terdaftar di Bursa Efek Indonesia 2013-2015) Jurnal Bisnis dan Ekonomi (JBE), Maret 2017, Hal. 24 – 32 Vol. 24, No.1
[11] Enny Wahyu Puspita Sari. Penggunaan Model Zmijewski, Springate, Altman Z-Score Dan Grover Dalam Memprediksi Kepailitan Pada Perusahaan Transportasi Yang Terdaftar Di Bursa Efek Indonesia
[12] Fahmi, Irham. 2013. *Analisis Laporan Keuangan.* Bandung: Alfabeta.
[13] Firda Mastuti, dkk. 2013. Altman Z-Score Sebagai Salah Satu Metode Dalam Menganalisis Estimasi Kebangkrutan Perusahaan (Studi Pada Perusahaan Plastik dan Kemasan yang Terdaftar (Listing) di Bursa Efek Indonesia periode etahun 2010 sampai dengan 2012)
[14] Fitria Wulandari, dkk. 2017 Analisis Prediksi Kebangkrutan Menggunakan Metode Altman (Z-Score) Pada Perusahaan Farmasi (Studi Kasus Pada Perusahaan Yang Terdaftar Di Bursa Efek Indonesia Tahun 2011-2015). BENEFIT Jurnal Manajemen dan Bisnis Volume 2, Nomor 1, Juni 2017
[15] Ghodratollah Talebnia, dkk. 2016 Evaluating and comparing the ability to predict the bankruptcy prediction models of Zavgren and Springate in companies accepted in Tehran Stock Exchange. Marketing and Branding Research 3(2016) 137-143
[16] Gitman, Lawrence J. 2003. Principles of managerial Finance, 10th edition, Boston: Addison-Wesley

[17] Hussain, H.I., Kamarudin, F., Thaker, H.M.T. & Salem, M.A. (2019) Artificial Neural Network to Model Managerial Timing Decision: Non-Linear Evidence of Deviation from Target Leverage, *International Journal of Computational Intelligence Systems*, 12 (2), 1282-1294.
[18] Harahap, Sofyan Syafri. 2009. "*Analisis Kritis Atas Laporan Keuangan*". Jakarta: Raja Grafindo Persada
[19] Hudah dan Lina Siti Nuril, 2011. Analisis perbandingan prediksi kabngkrutan model Altman modifikasi Z-Scoore Springate, Zmijewski, dan Ohlson pada perushaan manufaktur yang listing dalam swa 100
[20] Ikatan Akuntansi Indonesia. 2018. Standar Akuntansi Keuangan Efektif per 1 Januari 2018. Jakarta: Ikatan Akuntan Indonesia.
[21] K.R. Subramanyam 2014. *Analisis Laporan Keuangan*, Buku 1, Edisi 11, Jakarta, Salemba Empat.
[22] K.R. Subramanyam dan John J. Wild 2010. *Analisis Laporan Keuangan*, Buku 2, Edisi 10, Jakarta, Salemba Empat.
[23] Kasmir. 2014. Analisis Laporan Keuangan. Edisi Satu. Cetakan Ketujuh. Jakarta: PT Raja Grafindo Persada.
[24] Khalid Alkhatib and Ahmad Eqab Al Bzour. Predicting Corporate Bankruptcy of Jordanian Listed Companies: Using Altman and Kida Models 2011 International Journal of Business and Management Vol. 6, No. 3; March 2011.
[25] Lesmana, Rico, dan Surjanto, Rudy 2003. Financial Performance Analyzing. Jakarta: Elex Meddia Komputindo.
[26] Mardiasmo, 2007. Akuntansi Keuangan Dasar, edisi ke dua, penerbit BPFEUGM, Yogyakarta.
[27] Muammar Khaddafi, Dkk. (2017) Analysis Z-score to Predict Bankruptcy in Banks Listed in Indonesia Stock Exchange. International Journal of Economics and Financial Issues, 2017, 7(3), 326-330.
[28] Ni Made Evi Dwi Prihanthini, Maria M. Ratna Sari, (2013). Prediksi Kebangkrutan Dengan Model Grover, Altman Z-Score, Springate Dan Zmijewski Pada Perusahaan Food And Beverage Di Bursa Efek Indonesia. E-Jurnal Akuntansi Universitas Udayana 5.2 (2013): 417-435.
[29] Nur Hasbullah Matturungan, dkk. (2017). Manufacturing Company Bankruptcy Prediction In Indonesia With Altman Z-Score Model (2017). Jurnal of Applied Management (JAM) Volume 15 Number 1, March 2017 Indexed in Google Scholar.
[30] Peyman Imanzadeh, dkk. (2011). A Study of the Application of Springate and Zmijewski Bankruptcy Prediction Models in Firms Accepted in Tehran Stock Exchange. Australian Journal of Basic and Applied Sciences, 5(11): 1546-1550, 2011
[31] Queenaria Jayanti, Rustiana, 2015. Analisis Tingkat Akurasi Model – model Prediksi Kebangkrutan untuk memprediksi voluntary auditor switching (Studi pada perusahaan manufaktur yang terdaftar di BEI). MODUS Vol.27 (2): 87-108
[32] Qunfeng Liao, Seyed Mehdian (2016). Measuring Financial Distress and Predicting Corporate Bankruptcy: An Index Approach. REBS Volume 9, Issue 1, pp.33-51, 2016
[33] Salamat, S., lixia, N. Naseem, S., Muhammad Mohsin, M., Zia-ur-Rehman, M., Baig, S.A. 2020. Modeling cryptocurrencies volatility using Garch models: a comparison based on Normal and Student's T-Error distribution. Entrepreneurship and Sustainability Issues, 7(3), 1580-1596. https://doi.org/10.9770/jesi.2020.7.3(11)
[34] S. Munawir. 2007. Analisis Laporan Keuangan, Edisi Empat. Yogyakarta: PT. Liberty.
[35] Sartono Agus. 2010. Manejemen Keuangan Teori dan Aplikasi. Edisi 4. BPFE: Yogyakarta.
[36] Sekaran, Uma, dan Roger Bougie. 2016. Research Methods For business: A Skill-Building Approach. Edisi 7. Chichester: Wiley.
[37] Surapol Pongsatat, dkk. (2004). Bankruptcy Prediction for Large and Small Firms in Asia: A Comparison of Ohlson and Altman. Journal of Accounting and Croporate Governance Volume 1 Number 2, December 2004 pp. 1-13
[38] Syamsul Hadi, Atika Anggraeni. Pemilihan Prediktor Delisting Terbaik (Perbandingan Antara the Zmijewski Model, the Altman Model, Dan The Springate Model)
[39] Subramanyam K.R., Financial Statement Analyisis, Eleventh edition, Mc Graw-Hill International Edition, , 2009
[40] Tokhayeva, Z.O., Almukhambetova, B.Z., Keneshbayev, B., Akhmetova, K. 2020. Innovative processes' management in agriculture and food security: development opportunities. Entrepreneurship and Sustainability Issues, 7(3), 1565-1579. https://doi.org/10.9770/jesi.2020.7.3(10)
[41] DMD. (2016). Perusahaan Besar Bangkrut di Indonesia. Dikutip dari: https://ekbis.sindonews.com/read/1085897/39/perusahaan-besar-bangkrut-di-indonesia-1455640928 Diakses pada 5 maret 2018 (Pukul 15.45)
[42] IDX. (2019) Laporan keuangan dan Tahunan. Dikutip dari: https://www.idx.co.id/
[43] https://www.indonesia-investments.com/id/bisnis/komoditas/batu-bara/item236