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PREDICTION OF FINANCIAL DISTRESS USING THE ALTMAN AND ZMIJEWSKI MODELS

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Abstract. This study aims to analyze the prediction of financial distress in all non-financial firms listed on the Indonesia Stock Exchange (IDX) for the period 2021–2023 using the Altman Z-Score Model and the Zmijewski Model, as well as to compare the prediction accuracy levels of both models. Financial distress is a condition in which a firm experiences financial difficulties that may lead to bankruptcy. This study employs a quantitative approach with a descriptive method. The research sample consists of 250 firms determined by stratified random sampling and analyzed using the non-parametric Mann-Whitney test and prediction accuracy testing through the Bootstrapping method. The results show that there is a significant difference between the Altman Model and the Zmijewski Model in predicting financial distress. Furthermore, the Zmijewski Model shows a higher prediction accuracy of 95.1% compared to the Altman Model at 89.6%. These findings are expected to provide theoretical and practical contributions, particularly for decision-making by firm management, investors, and creditors.

Keywords: financial distress, Altman Z-Score, Zmijewski, accuracy

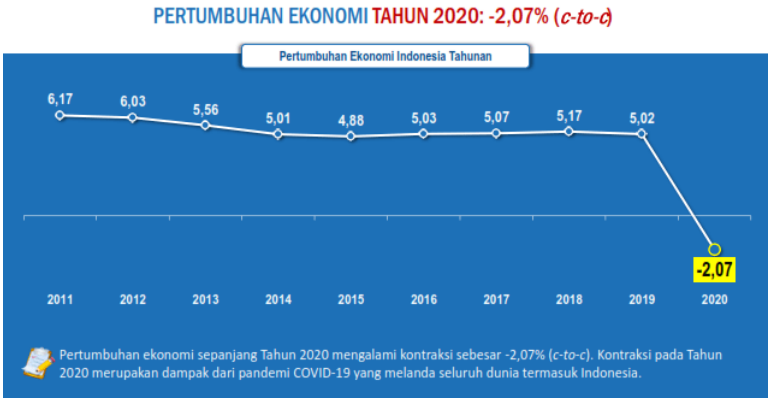
INTRODUCTION

Every firm has the primary aim of generating profits and developing over the long term. However, with increasing business competition, firm management faces challenges in creating effective strategies and thorough business planning to survive various business pressures. If a firm fails to withstand these conditions, the risk of financial distress increases.

Financial distress is a financial condition indicating that a firm is under financial pressure, which, if not promptly addressed, can lead to bankruptcy (Viciwati, 2020). This condition is generally characterized by a firm's inability to meet its financial obligations, whether in the form of debt payments or other operational liabilities. Financial distress can be caused by various factors, including declining operational performance, high debt burdens, or inefficiency in asset management. A firm's inability to pay its debts may ultimately result in bankruptcy (Papana & Spyridou, 2020).

In 2020, the global economy experienced a downturn due to the Covid-19 pandemic. Large-Scale Social Restrictions (PSBB) to reduce virus transmission affected business actors; many firms were forced to suspend operations, reduce business scale, or even liquidate due to financial difficulties (Fajarsari, 2022). Indonesia's economic growth itself declined by -2.07%. This decline caused many firms across sectors to face financial pressure. Some were forced to restructure debt, while others declared bankruptcy due to inability to survive during the crisis.

Figure 1. Economic Growth 2011 – 2020



Source: Central Statistics Agency, 2020

Entering 2021, Indonesia implemented economic recovery efforts in response to the pandemic. One of the government's measures was continuing the National Economic Recovery (PEN) program with a budget of IDR 699.4 trillion. This policy was designed to stimulate economic growth for industries affected by the pandemic. Nevertheless, some firms still went bankrupt due to the pandemic, such as PT Kayu Raya Indonesia (KRI) and Fabelio, declared bankrupt by the Central Jakarta Commercial Court on October 5, 2022. PT Kayu Raya Indonesia went out of business and failed to fully meet its obligations. KRI's bankruptcy was not only a continuation of pandemic impacts but also a result of management's inability to manage its resources. Previously, KRI had filed for debt restructuring or a

Postponement of Debt Payment Obligation (PKPU), which was granted, but eventually, KRI failed to reach an agreement with creditors and was declared bankrupt.

This phenomenon highlights the need for analysis to predict financial distress to prevent potential bankruptcy. Preventing bankruptcy requires supervision of financial conditions to assess a firm's financial health and predict future bankruptcy. Essentially, financial distress prediction cannot be measured in a short period but requires two to five years to forecast a firm's financial health. Early warnings of potential financial distress can be analyzed using various predictive models. Conducting financial distress analysis aims to prevent future bankruptcy; the earlier the prediction, the better it is for management in increasing vigilance and taking appropriate corrective actions to reduce and avoid financial problems (Saladin et al., 2022). Besides being a preventive effort, prediction also serves as a signal for firm management, investors, and creditors to make informed decisions. The information obtained is used by investors to evaluate potential return on investment, while creditors use it to assess creditworthiness. Understanding financial distress is crucial for investors, creditors, and firm management as it helps in strategic decision-making to prevent larger losses (Altman, 1968; Platt & Platt, 2002).

One of the popular and widely used methods to predict financial distress is the Altman Z-Score Model and the Zmijewski Model. The selection of these two models for analysis in this study is due to both being predictive models developed by Edward I. Altman and Mark E. Zmijewski, making their comparison relevant as both models have similar criteria. The Altman and Zmijewski models are capable of producing consistent scores, allowing their average results to be used as valid indicators of a firm's financial health (Matejić et al., 2022).

The Altman Model was first introduced by Edward I. Altman in 1968 as a tool to measure a firm's financial health and predict the likelihood of bankruptcy. This model is effective as a financial distress prediction tool (Artini & Astika, 2024). Altman used five financial ratios, namely working capital to total assets, retained earnings to total assets, earnings before interest and taxes to total assets, market value of equity to total liabilities, and sales to total assets, applying multiple discriminant analysis. This analysis explains how financial ratios with significant influence on an event were developed into a model that facilitates drawing conclusions.

Using the Altman Z-Score prediction model helps firms identify potential financial distress in a more measurable and accurate manner. The scores generated by this model are categorized into three zones: safe zone ($Z>2.99$), grey zone ($1.18<Z<2.99$), and distress zone ($Z<1.81$). In his initial study, Altman showed that the model has a high accuracy level, exceeding 70%, and can predict up to two years ahead (Altman, 1968). The model's advantages lie in its simplicity and its ability to provide early indications of financial conditions. However, over time, there emerged a need to further develop the model to make it more relevant to modern economic conditions and firm financial structures (Grice & Ingram, 2001).

Modifications to the Altman Z-Score model were first made to increase its accuracy and flexibility. In the modified Z-Score, Altman eliminated the X5 variable

(sales to total assets) because this ratio varies significantly across industries with different asset sizes. The resulting scores are categorized into three areas: safe zone ($Z>2.6$), grey area ($1.1<Z<2.6$), and distress zone ($Z<1.1$). A main reason for modification is to adjust the model to specific industry characteristics or geographical regions. For example, capital structures in emerging markets may differ from developed countries, so the ratios used in the original model need adjustment (Altman & Branch, 2015). In addition, regulatory changes and market dynamics also drive the need for model modification. Overall, the modified Altman Z-Score has successfully increased the prediction accuracy of financial distress in certain contexts, such as emerging markets, specific industry sectors, or changing economic conditions.

The Zmijewski X-Score, developed by Mark E. Zmijewski in 1984, is often used in analyzing a firm's financial health. The Zmijewski Model uses financial ratios to calculate a score indicating whether a firm is in financial distress (Zmijewski, 1984). These ratios include profitability, liquidity, and capital structure, analyzed to describe a firm's financial condition. The Zmijewski Model has the advantage of making predictions by incorporating more specific and relevant financial statement information compared to more general models. It combines three ratios: profitability (return on assets), leverage (debt ratio), and liquidity (current ratio). With a cutoff value of 0, if $X<0$, the firm is categorized as healthy; if $X>0$, the firm is categorized as unhealthy.

Zmijewski applied this model to 40 bankrupt firms and 800 non-bankrupt firms listed on the American and New York Stock Exchanges from 1972 to 1978. The sample achieved up to 99% prediction accuracy (Lutfiyyah & Bhilawa, 2021). The Zmijewski Model is significant and can be used in analyzing financial distress prediction for a firm (Edi & Tania, 2018)

Several studies report differing results. Artini & Astika (2024) stated that there is a significant difference between the Altman Z-Score Model and the Zmijewski Model in consumer cyclicals firms, with Altman's accuracy higher than Zmijewski. This aligns with Fahma & Setyaningsih (2019), where Altman Z-Score accuracy was higher than Zmijewski in retail firms. Another study by Apsari et al. (2024) reported that Zmijewski accuracy was higher than the Altman Z-Score in manufacturing firms in the tobacco sub-sector.

Based on these studies, inconsistencies exist regarding differences in prediction accuracy between the Altman Z-Score and Zmijewski models, necessitating further research. This study is novel in analyzing all non-financial firms listed on the Indonesia Stock Exchange from 2021 to 2023. Selecting all non-financial sectors aims to avoid distortions from financial sector characteristics, particularly in financial structure, regulations, and reporting methods. Including all non-financial sectors provides a comprehensive overview of financial distress in the real sector, improves model accuracy, and facilitates comparison and interpretation of results. This study analyzes financial distress prediction for all non-financial firms listed on the Indonesia Stock Exchange using the Altman Z-Score and Zmijewski models, then compares the prediction accuracy of both models.

RESEARCH METHOD

This study uses a descriptive research design with a quantitative approach to test the hypothesis regarding financial distress prediction for all non-financial firms listed on the Indonesia Stock Exchange (IDX) during the 2021–2023 period. The research location covers all non-financial firms on the IDX, with data obtained from the official website www.idx.co.id

. The research object is the level of financial distress prediction, measured using the modified Altman Z-Score and Zmijewski models, with indicators derived from financial ratios such as working capital/total assets, retained earnings/total assets, EBIT/total assets, book value of equity/book value of total debt, ROA, debt ratio, and current ratio (Sugiyono, 2020; Sagho & Merkusiwati, 2015).

The population of this study consists of 664 non-financial firms listed on the IDX during the 2021–2023 period. The research sample was determined using probability sampling with the Slovin formula at a 5% error rate, resulting in 250 firms, which were then selected using stratified random sampling based on industry sectors. The type of data used is secondary quantitative data obtained from firms' annual financial statements. Data were collected through non-participant observation, where the researcher acted only as an observer without direct involvement in the activities of the research object (Sugiyono, 2020).

The data analysis techniques include descriptive statistical analysis to provide an overview of data characteristics, normality tests to ensure the residual distribution of the model, hypothesis testing to examine the effect of independent variables on the dependent variable, and the Mann–Whitney test to compare the accuracy of the two prediction models. In addition, an accuracy test was conducted to measure the level of model precision in predicting firms' conditions as distressed or healthy, using classification criteria based on losses and debt increases over two consecutive years. Accuracy levels were calculated using the formula comparing correct predictions to the total sample size (Utama, 2016; Ghozali, 2019).

RESULTS AND DISCUSSION

Data Description and Research Results

This study used two bankruptcy prediction models to predict financial distress in the sampled non-financial firms, namely the Altman Z-Score model and the Zmijewski model. Each bankruptcy model involves analyzing specific financial ratios. Table 1 presents the financial ratios in the Altman Z-Score and Zmijewski models.

Table 1. Financial Ratios in the Altman Z-Score and Zmijewski Models

Altman Z-Score Model	Zmijewski Model
1. Working Capital/Total Assets	1. Return on Assets
2. Retained Earnings/Total Assets	2. Debt Ratio
3. Earnings Before Interest an Taxes/Total Assets	3. Current Ratio
4. Book Value of Equity/Book Value of Total Debt	

Source: Processed data, 2025

Based on Table 1, each financial distress prediction model, namely the Altman Z-Score and Zmijewski models, is used to predict bankruptcy in non-financial firms. Descriptive statistical analysis of the research variables provides information regarding the characteristics of the variables tested in each prediction model, including the number of observations, maximum value, minimum value, mean, and standard deviation.

Outliers

Outliers are cases where data have unique characteristics, appearing significantly different from other observations, marked by extreme values in a single variable or combination of variables (Ghozali, 2018). Outliers can occur due to several factors, such as errors in data entry or failures in handling missing values in computer programs. Outliers are not considered members of the population sampled but represent extreme values within the population distribution that do not follow a normal distribution. Outlier detection can be performed by determining a threshold value to categorize data as outliers, usually by converting data values into standardized scores or z-scores. For large samples exceeding 80 observations, standard scores are not applied; outliers can be determined if a data point falls between 3 to 4 standard deviations. In this study, 22 data points were identified as outliers. Therefore, from the original 250 sample data points, 22 outliers were removed, resulting in a total sample of 228.

Descriptive Statistics

Descriptive statistics are measures that describe the characteristics or distribution of sample data for each variable used in the study. Descriptive statistics explain data conditions in terms of mean, standard deviation, minimum, and maximum values for each variable. Based on the analysis of the collected data, the results of the descriptive analysis for the Altman Z-Score and Zmijewski models are presented in Table 2 as follows.

Table 2. Descriptive Statistics Analysis Results

	N	Minimum	Maximum	Mean	Standard Deviation
Altman ZScore	228	-10.50	23.93	4.01	4.29
Zmijewski XScore	228	-5.08	196.05	-0.38	15.03
Valid N (listwise)	228				

Source: Processed data, 2025

Based on the results of the descriptive statistical analysis, the number of observations in this study was 228, with the Altman model having a mean value of 4.01, a maximum value of 23.93, a minimum value of -10.50, and a standard deviation of 4.29. Since the standard deviation is greater than the mean, this indicates that the Altman model data are unevenly distributed.

The descriptive statistical analysis of the Zmijewski model shows a mean value of -0.38, a maximum value of 196.05, a minimum value of -5.08, and a standard

deviation of 15.03. As the standard deviation is greater than the mean, the Zmijewski model data are also unevenly distributed.

Normality Test

The normality test is used to examine whether the residuals of the regression model are normally distributed. A regression model is considered normal if the asymp. sig. (2-tailed) value is greater than 0.05. In this study, the normality test was conducted using non-parametric statistics with the One-Sample Kolmogorov-Smirnov test.

Table 3. One-Sample Kolmogorov-Smirnov Test Results

	Unstandardized Residual	
	Altman Z-Score	Zmijewski
N	228	228
Test Statistics	,085	,054
Asymp. Sig. (2-tailed)	,000c	.200c,d

Source: Processed data, 2025

Based on the data in Table 3, the asymp. sig. (2-tailed) value for the Altman Z-Score model is less than 0.05, indicating that the data in the Altman Z-Score model are not normally distributed. This is caused by the relatively large sample size and the presence of extreme values. The larger the sample size used in the study, the less likely the data are normally distributed (Pek et al., 2018).

The normality test results for the Zmijewski financial distress prediction model show an asymp. sig. (2-tailed) value greater than 0.05, specifically 0.200. Thus, the data in the Zmijewski prediction model are considered normally distributed.

Hypothesis Test

1) **Mann-Whitney test**

The Mann-Whitney test is used to compare two different groups. The purpose of this test is to determine whether the difference between the two models is statistically significant. A difference between the tested models is considered significant if the significance value ≤ 0.05.

Table 4. Mann - Whitney Test Results

	Score
Mann-Whitney University	4553,000
Asymp. Sig. (2-tailed)	0,000

Source: Processed data, 2025

Based on the data presented in Table 4, the asymp. sig. (2-tailed) value is less than 0.05. Therefore, it can be concluded that there is a significant difference between the financial distress prediction analysis based on the Altman Z-Score model and the prediction based on the Zmijewski model.

The first hypothesis states that there is a difference between the predictions based on the Altman Z-Score model and those based on the Zmijewski model. The test results in Table 4 show an asymp. sig. (2-tailed) value less than 0.05, indicating a significant difference between the two prediction models. Thus, the first hypothesis is accepted.

2) Accuracy Test

The accuracy test is used to measure the percentage of a model's ability to correctly predict the company's condition based on the entire research object (Ghozali, 2019). In the Altman model, companies categorized in the grey area were not included in the accuracy test.

Table 5. Model Predictions

	Atlman Model		**Zmijewsi Model**	
	Frequency	Presentation	Frequency	Presentation
Healthy	144	63.2	200	87.7
Distress	40	17.5	28	12.3
Grey Area	44	19.3		
Total	228	100.0	228	100.0

Source: Processed data, 2025

The predictions of the two models are presented in Table 5. Based on the table, the Altman model predicts 144 companies as healthy (63.2%), 40 companies as experiencing financial distress (17.5%), and 44 companies as in the grey area (19.3%). The Zmijewski model predicts 200 companies as healthy (87.7%) and 28 companies as experiencing financial distress (12.3%). The prediction accuracy of both models is shown in Table 6. From the table, the Altman model achieves an accuracy of 89.6%, while the Zmijewski model reaches 95.1%.

Table 6. Model Prediction Accuracy

	Total Prediction	Correct Prediction	Presentation
Altman	184	165	89.6
Zmijewski	228	217	95.1

Source: Processed data, 2025

The significance of the difference in model accuracy was tested using the bootstrapping method with 100 samples taken for each model at a 95% confidence interval. Based on the test results, the Zmijewski model has a higher mean difference value of 0.951 compared to the Altman model at 0.896, indicating a higher accuracy level than the Altman model, with significance less than 0.05 or 0.010. This means the mean differences are significantly different. The test results are presented in Table 7.

Table 7. Bootstrapping Test Results for Altman and Zmijewski Models

Bootstrap for One-Sample Test						
	Mean Difference	Bias	Std. Error	Sig. (2-tailed)	BCa 95% Confidence Interval	
					Lower	Upper
Altman's Reality Accuracy	.89674	-.00283	.02456	.010	.84346	.93478
Zmijewski's Accuracy of Reality	.95109	-.00011	.01269	.010	.92935	.96739

Source: Processed data, 2025

The second hypothesis states that there is a difference in accuracy between predictions based on the Altman model and predictions based on the Zmijewski model. The test results in Tables 6 and 7 show that the prediction accuracies of the two models differ. Predictions based on the Altman model indicate an accuracy of 89.6%, while predictions based on the Zmijewski model show an accuracy of 95.1%. This indicates that there is a significant difference in accuracy between the two prediction models, thus the second hypothesis is accepted.

Discussion of Research Results

Differences Between the Altman Z-Score Model and the Zmijewski Model

Based on the results of the Mann-Whitney test used to examine whether there is a difference between the two financial distress prediction models, namely the Altman Z-Score model and the Zmijewski model, the Asymp. Sig (2-tailed) value was 0.00 < 0.05. Therefore, it can be concluded that there is a significant difference between the Altman Z-Score model and the Zmijewski model in predicting financial distress in non-financial companies listed on the Indonesia Stock Exchange, so the first hypothesis is accepted. Based on the analysis of the financial statements of the selected non-financial companies as samples using the Altman Z-Score and Zmijewski formulas, the Altman model predicted 40 companies as experiencing financial distress, 144 companies as healthy, and 44 companies in the grey area. Meanwhile, the Zmijewski model predicted 28 companies as experiencing financial distress and 200 companies as healthy.

These research findings are consistent with studies by Anastasia & Riza (2023), Artini & Astika (2024), and Luigi & Prabowo (2019), which stated that there is a significant difference between financial distress predictions based on the Altman Z-Score model and the Zmijewski model. Similarly, research by Zakiyah et al. (2015) and Muzami & Yuliana (2021) also found significant differences between the Altman Z-Score model and the Zmijewski model in predicting financial distress.

Prediction Model With the Highest Accuracy

The second hypothesis states that there is a difference in accuracy between financial distress predictions based on the Altman Z-Score model and predictions

based on the Zmijewski model. Data analysis shows differences in the accuracy levels of the two models. The Altman Z-Score model predicted 144 companies as healthy, 44 companies in the grey area, and 40 companies as experiencing financial distress. After the accuracy test, where companies were considered in financial distress if they experienced losses and increased debt for two consecutive years, the Altman model incorrectly predicted 19 samples and correctly predicted 165 samples out of a total of 184 company observations, with an accuracy rate of 89.6%.

The Zmijewski model predicted 200 companies as healthy and 28 companies as experiencing financial distress. After applying the same accuracy criteria, the Zmijewski model incorrectly predicted 11 samples and correctly predicted 217 samples out of 228 company observations, achieving an accuracy of 95.1%.

It can be concluded that the Altman Z-Score model and the Zmijewski model have different prediction accuracy levels, with the Zmijewski model achieving higher accuracy at 95.1% compared to the Altman model at 89.6%.

In the bootstrap statistical test, the Zmijewski model had a higher mean difference value of 0.9510 compared to the Altman model at 0.8967, indicating a higher accuracy level than the Altman model. Both models showed significance below 0.05 or 0.010, meaning the mean differences are significantly different.

These results are consistent with the findings of Muzanni & Yuliana (2021) and Nilasari & Haryanto (2018), where the highest prediction accuracy was obtained using the Zmijewski model, followed by the Altman Z-Score model.

CONCLUSION AND SUGGESTIONS

Based on the results of the tests and data analysis in this study, the following conclusions can be drawn.

1) The financial distress prediction analysis based on the Altman Z-Score model, proxied by five financial ratio variables, namely Working Capital/Total Assets (WCTA), Retained Earnings/Total Assets (RETA), Earnings Before Interest and Taxes/Total Assets (EBITTA), and Book Value of Equity/Book Value of Total Debt (BVEBVTD), and the financial distress prediction analysis based on the Zmijewski model, using three financial ratio variables, namely Return on Assets (ROA), leverage proxied by Debt Ratio (DR), and liquidity proxied by Current Ratio (CR), shows a significant difference in predicting financial distress in non-financial companies listed on the Indonesia Stock Exchange during the 2021–2023 period.
2) There is a difference in accuracy between predictions based on the Altman Z-Score model and predictions based on the Zmijewski model. In the Altman model test, 40 companies were predicted to experience financial distress, 144 companies were predicted not to experience financial distress, and 44 companies were categorized in the grey area. Meanwhile, in the Zmijewski model test, 28 companies were predicted to experience financial distress, and 200 companies were predicted not to experience financial distress.
3) The Altman model incorrectly predicted 19 samples and correctly predicted 165 samples out of a total of 185 company observations, with an accuracy of 89.6%. The Zmijewski model incorrectly predicted 11 samples and correctly

predicted 217 samples out of 228 company observations, with an accuracy of 95.1%. In the bootstrap statistical test, the Zmijewski model had a higher mean difference value of 0.9510 compared to the Altman model at 0.8967. Therefore, it can be concluded that the prediction accuracy of the Zmijewski model is higher than that of the Altman model.

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