# Which Model Is the Most Accurate? A Comparative Study of Bankruptcy Prediction Models in Indonesia's Automotive Sector

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**Abstract**

**Purpose:** Financial distress has become a critical issue in corporate finance as it reflects a company's ability to maintain business continuity before experiencing bankruptcy. The purpose of this study is to analyze and compare the accuracy levels of the Altman Z-Score, Springate, and Zmijewski models in predicting financial distress among automotive sub-sector companies listed on the Indonesia Stock Exchange during the 2019–2022 period.

**Methodology:** This study employs a quantitative research approach using secondary data obtained from the annual financial statements of automotive sub-sector companies listed on the Indonesia Stock Exchange for the 2019–2022 period. The sample consists of 44 companies selected based on predetermined criteria. The analysis method involves descriptive statistical analysis and the application of the Altman Z-Score, Springate, and Zmijewski models to measure prediction accuracy in identifying financial distress.

**Findings:** The findings indicate that the Altman Z-Score and Springate models can be used to predict financial distress; however, their accuracy levels are relatively low, at 22% and 61% respectively, with higher type error rates. Conversely, the Zmijewski model demonstrates superior predictive performance with an accuracy rate of 93% and a type error of 7%, suggesting it is the most effective model for predicting financial distress potential among automotive sub-sector companies in Indonesia. These results highlight that the Zmijewski model provides the most reliable identification of financial distress compared to the other models.

**Originality:** The originality of this study lies in its comparative analysis of three well-known financial distress prediction models, Altman Z-Score, Springate, and Zmijewski, explicitly applied to Indonesia's automotive sub-sector during the post-pandemic period (2019–2022). This focus provides new empirical evidence on model accuracy within an industry significantly affected by economic fluctuations and supply chain disruptions.

**Practical implications:** The findings provide valuable insights for investors, managers, and policymakers in assessing financial distress risk and improving financial decision-making within the automotive industry.

**Keywords:** Financial distress, bankruptcy prediction, Altman Z-Score, Springate, Zmijewski, automotive industry.

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## Introduction

COVID-19, which began in late 2019, has had a multidimensional impact on the global economy. International organizations such as the International Monetary Fund (IMF) and the World Bank reported that the pandemic triggered economic contractions in nearly all countries, making it one of the deepest crises since the Great Depression (International Monetary Fund [IMF], 2020; World Bank, 2020). The Organisation for Economic Co-operation and Development (OECD, 2020) noted that mobility restrictions and disruptions in global supply chains caused a significant slowdown in production and international trade activities. The impact was also felt in Indonesia, where national economic growth in the first quarter of 2020 recorded a 2.97% year-on-year increase but contracted by 2.41% compared to the previous quarter (Badan Pusat Statistik [BPS], 2020). The implementation of Pembatasan Sosial Berskala Besar (PSBB) since March 2020 further weakened domestic economic activities, particularly in household consumption and the manufacturing industry. This macroeconomic instability exerted pressure on corporate performance, reflected in declining profitability, cash flow, and debt repayment capacity. Such conditions indicate the onset of financial distress, a critical phase that precedes potential financial distress if not promptly addressed (Rachmawati, Maulana, & Nugroho, 2022).

Moreover, more recent data indicates the severity of the shock and uneven recovery. The IMF's 2022 Article IV Consultation with Indonesia reported that output declined by nearly eight percentage points during the first and second quarters of 2020, underscoring the depth of the downturn (IMF, 2022). At the same time, the domestic automotive industry, one of the country's key manufacturing sectors, has faced prolonged headwinds. A 2023 industry report noted that car sales in Indonesia fell by approximately 10.9% in 2024 compared to 2023, highlighting the lingering effects of demand weakness (Indonesia-Investments, 2025). These developments suggest that persistent sector-specific pressures, in addition to macroeconomic turbulence, further elevate the risk of financial distress for firms operating in capital-intensive and globally linked industries, such as automotive manufacturing.

According to Platt and Platt (2002), *financial distress* refers to a state of financial difficulty that precedes actual insolvency or liquidation. Although firms aim for sustainable profitability, economic fluctuations, declining demand, and poor financial management can lead to continuous losses and ultimately financial distress (Setyowati & Sari, 2019). Such conditions are typically reflected in declining profitability and an inability to meet financial obligations (Rachmawati, Maulana, & Nugroho, 2022). Based on Signaling Theory, information asymmetry between management and external parties influences perceptions of a company's financial health. Financial reporting thus serves as a medium for management to convey performance signals that aid in decision-making (Primasari, 2017). When financial performance deteriorates, some firms fail to fulfill obligations and may undergo debt restructuring or bankruptcy due to excessive external financing unsupported by adequate cash flow (Sidik, 2020).

The automotive sector serves as one of the key pillars of Indonesia's national economy, contributing significantly to the gross domestic product (GDP) through production, employment, and vehicle exports. However, since the onset of the COVID-19 pandemic in early 2020, this sector has faced considerable pressure. Several automotive companies have been identified as experiencing financial distress, and some even filed for debt restructuring. For instance, PT Nipress Tbk (NIPS) experienced a stock suspension due to financial distress. At the same time, PT Grand Kartech Tbk was declared bankrupt by the Central Jakarta District Court (Wati, Kurniawati, & Permatasari, 2022). Similarly, the leading automotive company PT Astra International Tbk (ASII) reported an estimated 40 percent decline in vehicle sales during the pandemic (Sidik, 2020). This phenomenon illustrates that although the automotive industry has been designated a priority sector under the *Making Indonesia 4.0* program, it has not been fully resilient to global economic disruptions caused by the pandemic.

Interestingly, prior to the pandemic crisis, the automotive industry had shown a growth

trend. According to the *Gabungan Industri Kendaraan Bermotor Indonesia* **(**GAIKINDO, 2020), the car ownership ratio in Indonesia increased significantly in 2019. The 12 percent growth of the middle-class population led to an increase in vehicle ownership from approximately 80–87 units to 99 units per 1,000 inhabitants. This trend was expected to serve as a key driver for the expansion of domestic motor vehicle production activities. Structurally, Indonesia hosts 22 automotive manufacturing and assembly companies with a total production capacity of 2.2 million units per year. In addition, there are approximately 550 tier-1 automotive component companies and more than 1,000 tier-2 and tier-3 suppliers that support the national industrial supply chain (GAIKINDO, 2020; Ministry of Industry of the Republic of Indonesia, 2020).

According to data from GAIKINDO (2020), the total production of motor vehicles dropped sharply from 1,286,848 units in 2019 to only 690,176 units in 2020. This decline was primarily driven by weakened consumer demand due to social restriction policies and the decline in household purchasing power. In April 2020, four-wheeled vehicle sales plummeted by 90 percent, while retail sales decreased by 70 percent compared to the previous period (Ansori, 2020). This marked the lowest performance in more than a decade, making it extremely difficult for industry to achieve its annual sales target of 600,000 units. Furthermore, GAIKINDO reported that wholesale vehicle sales from manufacturers to dealers fell by 48.35 percent, reaching 532,027 units in 2020, compared to 1,030,126 units in 2019 (Rahardiansyah, 2021). These figures clearly demonstrate that the COVID-19 pandemic exerted extraordinary pressure on Indonesia's automotive industry, consequently increasing the risk of financial distress among automotive companies.

In assessing the financial distress conditions of automotive firms, it is essential to employ analytical models that accurately depict the financial status of listed companies. Numerous studies have tested various financial distress prediction models across different industries, and three models that are widely recognized for their predictive performance are the Altman Model, the Springate Model, and the Zmijewski Model. The Altman Model, developed by Edward I. Altman (1968), is known for its Z-Score formula, which initially utilized five financial ratios and was later expanded to twenty-two to estimate the likelihood of corporate bankruptcy. This model has been further refined to accommodate the characteristics of both public and private firms.

In a study by Rubiyah and Wahyuni (2021), the Altman Z-Score Model achieved the highest accuracy rate of 76.00% in predicting financial distress, making it one of the most reliable models for identifying potential bankruptcy. However, these results contrast with Fatmawati (2012), who found that the Altman Model had the lowest accuracy rate, approximately 36%, compared to other predictive methods. On the other hand, Primasari (2017) supported Wahyuni and Rubiyah's findings, suggesting that the Altman Z-Score remains one of the most effective models for detecting corporate financial difficulties, particularly due to its higher coefficient of determination ($R^2$) and F-test significance compared to alternative models.

The Springate Model, introduced by Springate (1978) as a variant of the Altman Model, simplifies the financial distress prediction approach by selecting four financial ratios from nineteen potential candidates, with a primary emphasis on profitability ratios (Springate, 1978). In the study conducted by Rahmawati et al. (2018), the Springate Model achieved an accurate rate of 81.25% in predicting bankruptcy, although it was not identified as the most accurate method. Conversely, Sari (2014) found that the Springate Model was indeed the most accurate model, with an accuracy rate of 33.33% and an error rate of only 12.12%. Supporting these findings, Munawarah and Hayati (2019) confirmed that the Springate Model can be effectively used for financial distress prediction. However, its predictive quality tends to be relatively lower compared to other models.

The Zmijewski Model, developed by Mark Zmijewski (1984), employs a discriminant analysis approach that incorporates liquidity, leverage, and performance (ROA) ratios as the foundation for prediction (Zmijewski, 1984). Research by Huda et al. (2019) found that the Zmijewski Model demonstrated the highest predictive accuracy, reaching 96.3%, with a Type I

error of 1.8% and Type II error of 0%. In contrast, Rahmawati et al. (2018) reported that the Zmijewski Model achieved an accurate rate of 87.5% with an error rate of 12.5%. Furthermore, Munawarah and Hayati (2019) reinforced the Zmijewski Model's position as the most accurate predictive method; their findings indicated that this model exhibited a positive and significant influence on the probability of financial distress at a 5% significance level.

The fluctuations in total production and sales experienced by the Indonesian automotive industry from 2019 to 2021 were crucial in selecting this sector as the focus of this financial distress analysis. The automotive industry is inherently complex and high-risk, so early and accurate predictions through these models are crucial for mitigating potential bankruptcy and preventing further financial losses.

## Literature Review

### Signalling Theory

Signalling Theory explains that there exists information asymmetry between management, as the internal decision-maker of a company, and external parties such as investors, creditors, and shareholders. Information asymmetry occurs when management possesses access to internal company information that is not fully known to external stakeholders (Spence, 1973). In financial reporting contexts, the theory posits that management uses financial statements to transmit signals aimed at reducing such imbalances. These signals may come as either *good news* (reflecting strong performance and promising outlooks) or *bad news* (indicating potential financial problems or distress) (Connelly, Certo, Ireland, & Reutzel, 2011). Recent studies further bolster this theoretical foundation: for instance, Uddin, Das, & Hasan (2024) demonstrated how profitability, liquidity, and leverage ratios function as signals of financial distress, and Kurniawan & Nugroho (2025) illustrated how ESG performance serves as a signaling mechanism in Indonesian firms during performance shortfalls. According to Primasari (2017), Signaling Theory provides the conceptual basis for assessing whether a company's financial condition is sound or deteriorating based on its disclosed reports. By sending appropriate signals, management can enhance investor confidence and reduce uncertainty in decision-making. Consequently, Signaling Theory remains a pivotal theoretical underpinning in research focusing on the prediction of corporate financial conditions.

### Financial Distress

Platt and Platt (2002), financial distress represents a stage of financial deterioration that occurs before a company experiences actual bankruptcy or liquidation. This condition is characterized by declining financial performance and the emergence of negative indicators in financial statements, such as reduced profitability, increasing debt levels, and a diminished ability to meet short-term obligations.

From a financial model perspective, the primary causes of financial distress are unhealthy capital structures and liquidity constraints, even when the firm's asset composition appears theoretically balanced. This suggests that a company may appear stable in the long term but still face short-term bankruptcy risks if its cash flow is poorly managed (Whitaker, 1999). In contrast, the neoclassical model posits that financial distress can arise from managerial inefficiencies in allocating corporate resources, such as poor investment and financing decisions (Brédart, 2014).

Financial distress can be classified into several categories. First, economic failure occurs when total revenues are insufficient to cover operational and capital costs. Second, business failure refers to a situation where a firm ceases operations to minimize losses to creditors. Third, technical insolvency arises when a company cannot meet its maturing financial obligations. Fourth, insolvency in bankruptcy describes a state in which total liabilities exceed the market

value of assets. Finally, legal bankruptcy is a formal condition in which a company is declared bankrupt through a court decision (Ekonomi, 2019; Platt & Platt, 2002).

Understanding these classifications enables firms to detect early warning signs of financial distress and implement strategic actions to prevent bankruptcy. Such financial analysis is particularly vital in high-risk industries that are heavily influenced by market dynamics.

Financial distress is generally indicated by deteriorating financial ratios reflecting declining performance. These indicators include decreased asset values, reduced sales, lower profitability and earnings, weakened working capital, and an increased debt-to-asset ratio (Rubiyah & Wahyuni, 2021). While financial distress does not necessarily imply absolute bankruptcy, it serves as an early warning signal for potential financial problems in the future. For instance, highly leveraged firms tend to face financial distress risks more rapidly than firms with healthier capital structures (Platt & Platt, 2002).

Predicting financial distress provides strategic advantages for firms by allowing management to identify and mitigate potential financial issues before they escalate into insolvency. Moreover, conducting regular assessments of a company's financial health enhances cost efficiency and operational effectiveness, enabling the firm to achieve profitability targets in line with strategic planning **(**Andriawan & Salean, 2016; Brédart, 2014). Consequently, financial distress prediction analysis constitutes a crucial component of corporate risk management.

Financial distress prediction can be performed through financial ratio analysis using established predictive models such as the Altman Z-Score, Springate, and Zmijewski models. These models have proven effective in identifying early signs of financial difficulty and supporting stakeholders in making accurate investment and financial decisions (Altman, 1968; Huda et al., 2019).

**Financial Statements**

Financial statements represent the final output of the accounting process, providing information about an entity's financial position and performance over a specific period. This information serves as a foundation for various stakeholders in making economic decisions—both internal parties, such as management and owners, and external parties such as investors, creditors, and regulators (Hamdani, 2018). According to Sari (2020), financial statements describe a company's performance results during an accounting period and can be used as tools for evaluation and strategic business planning in the future.

In general, financial statements consist of the statement of financial position (balance sheet), income statement, statement of changes in equity, cash flow statement, and notes to the financial statements, which explain accounting policies and provide additional details regarding the primary financial statement components (Kieso, Weygandt, & Warfield, 2020). Based on the Indonesian Financial Accounting Standards (PSAK) No. 1 (2009), the objective of preparing financial statements is to provide information about the entity's financial position, financial performance, and cash flows that are useful to users in making economic decisions and to demonstrate management's accountability for the resources entrusted to it (Ikatan Akuntan Indonesia [IAI], 2009).

Furthermore, financial statements serve not only as a reporting medium but also as an analytical tool to predict future financial conditions and potential risks. A systematic financial statement analysis helps firms identify performance trends, assess resource management efficiency, and minimize potential financial problems that may lead to financial distress (Brigham & Houston, 2019). Therefore, financial statements play a strategic role in supporting effective decision-making and ensuring the long-term sustainability of business operations.

## Hypotheses

The Altman Z-Score model is a multiple discriminant analysis (MDA) technique that employs a combination of financial ratios to predict a company's likelihood of experiencing financial distress. Developed by Edward I. Altman (1968), this model integrates four primary financial ratios that represent liquidity, profitability, and solvency aspects of a firm's performance. The first variable, Working Capital to Total Assets ($X_1$), represents a liquidity ratio, which indicates the relationship between a company's cash and current assets. This ratio demonstrates the firm's ability to generate net working capital from its total assets. It is calculated by dividing net working capital by total assets (Altman, 1968). The second variable, Retained Earnings to Total Assets ($X_2$), is a profitability ratio that measures a company's capacity to generate retained earnings from its total assets. This ratio reflects the cumulative profitability and the extent to which the company's growth has been financed through internally generated funds (Brigham & Houston, 2019). The third ratio, Earnings Before Interest and Taxes (EBIT) to Total Assets ($X_3$), also serves as a profitability indicator. It measures how efficiently a company's assets generate earnings before interest and tax payments. This ratio can also indicate the productivity of borrowed funds in generating profits (Kieso, Weygandt, & Warfield, 2020). The fourth ratio, Market Value of Equity to Book Value of Total Debt ($X_4$), represents a solvency ratio, assessing the extent to which a company's assets are financed through debt. This ratio provides insight into the firm's financial stability and leverage structure, demonstrating its ability to meet long-term obligations (Gitman & Zutter, 2015).

Empirical studies have demonstrated the predictive strength of the Altman Z-Score model. Hikmah (2019) found that the model possesses a high level of accuracy in predicting corporate bankruptcy. Similarly, Setyaningrum (2020) reported that the Altman Z-Score remains one of the most reliable models for assessing financial distress among firms. Based on these findings, the following hypothesis is proposed:

H1: The Altman Z-Score model can predict the likelihood of bankruptcy in a company.

The Springate model utilizes multiple discriminant analysis (MDA) as a statistical technique to identify the most significant financial ratios that influence the likelihood of corporate failure. This model, developed Springate (1978) based on Altman's approach, was refined to include only four financial ratios that effectively predict a company's potential bankruptcy (Springate, 1978; Hapsari & Sudiyatno, 2021). The first ratio, Working Capital to Total Assets ($X_1$), is a liquidity ratio that reflects a firm's ability to generate working capital from its total assets. It is calculated by dividing net working capital (current assets minus current liabilities) by total assets (Gitman & Zutter, 2015). This ratio indicates how efficiently the company manages its short-term assets to meet operational needs. The second ratio, Earnings Before Interest and Taxes (EBIT) to Total Assets ($X_2$), represents a profitability ratio that measures the firm's ability to generate profits from its total assets before paying interest and taxes. It demonstrates the efficiency of asset utilization in generating operating income (Brigham & Houston, 2019). The third ratio, Earnings Before Taxes to Current Liabilities ($X_3$), is also a profitability ratio that assesses a company's capacity to earn profits before tax relative to its current liabilities. This ratio measures how effectively the company can cover its short-term obligations through its pre-tax earnings (Kieso, Weygandt, & Warfield, 2020). The fourth ratio, Sales to Total Assets ($X_4$), is classified as an activity ratio, which measures the efficiency of asset utilization in generating sales revenue. It reflects the firm's operational effectiveness in managing assets, inventories, and receivables to support revenue growth (Ross, Westerfield, & Jordan, 2019).

Empirical evidence supports the predictive power of the Springate model. Sari (2014) found that the Springate model exhibited the highest accuracy among several bankruptcy prediction models tested. Similarly, Rachmawati et al. (2022) reported that the model successfully

identified a greater proportion of financially distressed firms with high predictive accuracy. Based on these findings, the following hypothesis is proposed:
H2: The Springate model can predict the likelihood of bankruptcy in a company.

The Zmijewski model is a development of earlier bankruptcy prediction models. It utilizes a logit (probit) regression approach based on selected financial ratios to assess a firm's likelihood of financial distress **(**Zmijewski, 1984). This model focuses on three key financial ratios that represent the dimensions of profitability, leverage, and liquidity in corporate financial performance. The first ratio, Return on Assets (ROA), belongs to the profitability ratio category. ROA measures a company's ability to generate net income from its total assets and reflects managerial efficiency in utilizing assets to create profits (Faldiansyah, 2020; Brigham & Houston, 2019). It is calculated by dividing net income by total assets. The second ratio, Debt Ratio, is classified as a solvency (leverage) ratio, which evaluates the proportion of a company's assets financed through debt. A higher leverage ratio indicates greater financial risk, as a company relies more heavily on external financing sources. This ratio is essential in understanding the firm's long-term solvency and capital structure management (Hamdani, 2018; Gitman & Zutter, 2015).

The third ratio, Current Ratio, measures a company's liquidity position, indicating the firm's capability to meet its short-term obligations using current assets that can be readily converted into cash. A higher current ratio reflects better short-term financial stability (Hamdani, 2018; Ross, Westerfield, & Jordan, 2019). Empirical studies support the accuracy and robustness of the Zmijewski model in predicting financial distress. Fatmawati (2012) found that the Zmijewski model demonstrated the highest accuracy and effectiveness in predicting bankruptcy among Indonesian firms. Similarly, Huda et al. (2019) confirmed that this model outperformed other prediction methods in identifying firms with potential financial distress. Based on the above findings, the following hypothesis is proposed.
H3: The Zmijewski model can predict the likelihood of bankruptcy in a company.

## Research Methods

This quantitative research aims to obtain empirical evidence for predicting financial distress using financial ratio analysis. The method for selecting subjects includes a description of the population and sample. The population represents the number of subjects and the area covered. The population in this study is companies in the automotive subsector listed on the Indonesia Stock Exchange during the 2019-2022 period. The sampling technique in this study was purposive sampling using established criteria.

Based on the above criteria, the following company sample data was obtained:

**Table 1**. Automotive Companies listed on the IDX

| No | Company name | Stock Code |
|---|---|---|
| 1 | Astra International Tbk | ASII |
| 2 | Astra Otoparts Tbk | AUTO |
| 3 | Gajah Tunggal Tbk | GJTL |
| 4 | Indomobil Sukses International Tbk | IMAS |
| 5 | Indospring Tbk | INDS |
| 6 | Multi Prima Sejahtera Tbk | LPIN |
| 7 | Prima Alloy Steel Universal Tbk | PRAS |
| 8 | Selamat Sempurna Tbk | SMSM |
| 9 | Indo Kordsa Tbk | BRAM |
| 10 | Goodyear Indonesia Tbk | GDYR |
| 11 | Multistrada Ara Sarana Tbk | MASA |

The data analysis technique employed multiple discriminant analyses, utilizing the Altman Z-Score, Springate, and Zmijewski models, which were calculated using Microsoft Excel. The

accuracy level and error types for each model were calculated.

Descriptive statistics describe collected data (Ghozali, 2013). In descriptive statistics, data can be described using the mean, standard deviation, variance, maximum, minimum, sum, range, skewness, and kurtosis. The mean indicates the average value of the sample, the maximum indicates the highest value of the entire sample, the minimum indicates the lowest value of the entire sample, and the standard deviation indicates the measure of data dispersion across the entire sample. The resulting data are used as a general overview without any conclusions or calculations regarding the analysis of each predictive model.

**Table 2.** Calculation Model

| Model | Score Calculation | Cut-Off Provisions |
|---|---|---|
| Model Altman *Z-Score* | Z = 6,56 X1 + 3,26 X2 + 6,72 X3 +1,05 X4<br>$X_1$: Working Capital / Total Assets<br>$X_2$: Retained Earnings / Total Assets<br>$X_3$: Earnings Before Interest and Taxes (EBIT) / Total Assets<br>$X_4$: Book Value of Equity / Total Liabilities | 1. A Z-score <1.1 indicates the company is bankrupt.<br>2. A Z-score between 1.1 and 2.60 indicates the company is in the gray zone.<br>3. A Z-score>2.60 indicates the company is not bankrupt. |
| Model *Springate* | S = 1,03 A + 3,07 B + 0,66 C + 0,4 D<br>A: Working Capital / Total Assets<br>B = Net Profit Before Interest and Taxes / Total Assets<br>C = Net Profit Before Taxes / Current Liabilities<br>D = Sales / Total Assets | 1. S score is > 0.862, the company is classified as healthy.<br>2. S score is < 0.862, the company is classified as potentially bankrupt. |
| Model *Zmijewski* | X = -4,3 – 4,5 + 4,5 X1 + 5,7 X2 + 0,004 X3<br>$X_1$ = Return on Assets (ROA)<br>$X_2$ = Debt Ratio (Leverage Ratio)<br>$X_3$ = Current Ratio | 1. X score ≥ 0, the company is predicted to be experiencing financial distress.<br>2. X Score < 0, the company is predicted not to be experiencing financial distress. |

The accuracy level was calculated to assess each analysis model. The accuracy level was calculated using the following formula from Altman (1986):

$$Accuracy\ Level = \frac{\text{Number of Correct Predictions}}{Number\ of\ Samples} x100\%$$

The number of correct predictions is the total number of automotive companies declared not to be facing financial distress, as calculated using the Altman z-score, Springate, and Zmijewski analysis models. The sample size represents the total number of automotive companies selected for the study.

The accuracy level results were then calculated using the error rate for all models used, namely the Altman z-score, Springate, and Zmijewski analysis models. The formula for calculating the error rate is as follows:

$$Type\ Error = \frac{Number\ of\ Errors}{Number\ of\ Samples}$$

The number of errors is the total of all samples of automotive companies declared to be facing financial distress.

## Results and Discussion

This study aims to determine whether there is a condition of financial distress in automotive companies listed on the Indonesia Stock Exchange using the Altman Z-Score model, the Springate model, and the Zmijewski model.

**Table 3.** Sample Determination Results

| No | Information | Amount |
|---|---|---|
| 1. | All Automotive sub-sector companies listed on the Indonesia Stock Exchange for the 2019-2022 period. | 13 |
| 2. | Listed as an active issuer during the 2019-2022 period | 13 |
| **Total sample does not meet the criteria** | | (2) |
| **Company Sample** | | 11 |
| **Total sample (n x research period) (11 x 4)** | | 44 |

Based on the sample criteria, two companies did not meet the criteria, failing to report periodic financial statements in their annual financial statements for the 2019-2022 period. The purpose of the descriptive analysis was to describe each tabulated data item from the Altman Z-Score, Springate, and Zmijewski models, whose values were obtained from the financial statements of companies in the automotive sector. Descriptive statistics were processed using SPSS V25, which produces a description of the data based on the average (mean), standard deviation, maximum value, and minimum value. The results of the descriptive statistical analysis are presented as follows:

**Table 4.** Descriptive Statistics

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Current Asset | 44 | 111.057,26 | 179.818.000,00 | 17.557.495,31 | 43.294.498,67 |
| Current Liabilitis | 44 | 10.782,09 | 119.198.000,00 | 12.832.579,05 | 29.690.076,21 |
| Working Capital | 44 | (60.620.000) | 7.553.594,00 | (4.724.916,26) | 14.597.967,71 |
| Retained Earning | 44 | (588.672,20) | 17.535.000,00 | 1.340.268,98 | 4.041.963,58 |
| EBIT | 44 | (48.489.241,00) | 50.390.000,00 | 2.551.316,71 | 13.105.176,76 |
| Total Equity | 44 | 284.023,38 | 243.720.000,00 | 21.265.839,29 | 55.718.949,34 |
| Total Liabilitas | 44 | 26.856,69 | 204.111.000,00 | 21.884.278,17 | 51.143.735,44 |
| Sale | 44 | 88.357,60 | 301.379.000,00 | 27.757.745,75 | 68.564.534,40 |
| Net Profit | 44 | (545.893,20) | 28.944.000,00 | 2.173.806,13 | 6.428.921,70 |
| Gross Profit | 44 | 1.149,44 | 63.166.000,00 | 5.552.227,22 | 14.220.015,84 |
| Total Aset | 44 | 310.880,07 | 413.297.000,00 | 43.147.055,00 | 105.121.881,79 |

This study analyzes the financial distress conditions of automotive subsector companies listed on the Indonesia Stock Exchange (IDX) during 2019–2022 using the Altman Z-Score model, which employs four key ratios: *working capital to total assets ($X_1$)*, *retained earnings to total assets ($X_2$)*, *earnings before interest and taxes to total assets ($X_3$)*, and *market value of equity to total liabilities ($X_4$)*. According to Altman (1968), profitability and capital structure ratios play a significant role in detecting potential bankruptcy. A lower Z-score indicates a higher probability of financial distress (Rudianto, 2013; Almamy, Aston, & Ngwa, 2016).

The analysis revealed varied financial conditions across automotive firms in Indonesia. PT Astra International Tbk (ASII) and PT Astra Otoparts Tbk (AUTO) were generally within the grey area during 2019–2021, reflecting moderate financial health amid declining sales and supply chain disruptions caused by the COVID-19 pandemic (Ajaib, 2021; Nurdiana, 2020). Both firms demonstrated recovery in 2022, driven by improved domestic demand and cost efficiency strategies.

**Table 5.** Result *Altman Z-Score*

| NO | CODE | YEAR | X1 | X2 | X3 | X4 | Z-SCORE | RESULT |
|---|---|---|---|---|---|---|---|---|
| | | | 6,56 | 3,26 | 6,72 | 1,05 | | |
| 1 | **ASII** | 2019 | -0,083 | 0,037 | 0,097 | 0,724 | 0,990 | BR |
| | **PT Astra International Tbk** | 2020 | -0,138 | 0,026 | 0,064 | 0,853 | 0,508 | BR |
| | | 2021 | -0,154 | 0,040 | 0,088 | 1,421 | 1,207 | ZA |
| | | 2022 | -0,147 | 0,042 | 0,122 | 1,437 | 1,505 | ZA |
| 2 | **AUTO** | 2019 | -0,131 | 0,030 | 0,070 | 1,947 | 1,748 | ZA |
| | **PT Astra Otoparts Tbk** | 2020 | -0,157 | -0,013 | 0,008 | 2,106 | 1,192 | ZA |
| | | 2021 | -0,136 | 0,029 | 0,045 | 2,322 | 1,942 | ZA |
| | | 2022 | -0,171 | 0,055 | 0,094 | 2,386 | 2,193 | ZA |
| 3 | **GJTL** | 2019 | -0,142 | 0,014 | 0,024 | 0,494 | -0,203 | BR |
| | **PT Gajah Tunggal Tbk** | 2020 | -0,162 | 0,018 | 0,027 | 0,627 | -0,164 | BR |
| | | 2021 | -0,196 | 0,002 | 0,005 | 0,635 | -0,574 | BR |
| | | 2022 | -0,187 | -0,010 | -0,010 | 0,613 | -0,682 | BR |
| 4 | **IMAS** | 2019 | 0,107 | 0,003 | 0,008 | 0,221 | 1,002 | BR |
| | **PT Indomobil Sukses International Tbk** | 2020 | 0,121 | -0,012 | -1,002 | 0,288 | -5,675 | BR |
| | | 2021 | 0,148 | -0,006 | 0,000 | 0,336 | 1,305 | ZA |
| | | 2022 | 0,131 | 0,005 | 0,166 | 0,327 | 2,333 | ZA |
| 5 | **INDS** | 2019 | -0,280 | 0,012 | 0,046 | 9,313 | 8,288 | TB |
| | **PT Indospring Tbk** | 2020 | -0,297 | -0,002 | 0,027 | 9,275 | 7,963 | TB |
| | | 2021 | -0,292 | 0,029 | 0,065 | 4,235 | 3,067 | TB |
| | | 2022 | -0,268 | 0,041 | 0,076 | 2,883 | 1,914 | ZA |
| 6 | **LPIN** | 2019 | -0,400 | 0,092 | 0,097 | 10,05 | 8,876 | TB |
| | **PT Multi Prima Sejahtera Tbk** | 2020 | -0,400 | 0,020 | 0,025 | 8,482 | 6,516 | TB |
| | | 2021 | -0,308 | -0,085 | 0,082 | 10,576 | 9,359 | TB |
| | | 2022 | -0,317 | 0,060 | 0,094 | 9,325 | 8,543 | TB |
| 7 | **PRAS** | 2019 | 0,218 | -0,026 | -0,032 | 0,638 | 1,795 | ZA |
| | **PT Prima Alloy Steel Tbk** | 2020 | -0,166 | -0,003 | 0,000 | 0,452 | -0,623 | BR |
| | | 2021 | -0,123 | 0,000 | 0,000 | 0,424 | -0,364 | BR |
| | | 2022 | -0,056 | -0,057 | -0,070 | 0,311 | -0,698 | BR |
| 8 | **SMSM** | 2019 | -0,540 | 0,078 | 0,265 | 2,053 | 0,648 | BR |
| | **PT Selamat Sempurna Tbk** | 2020 | -0,562 | 0,044 | 0,203 | 2,065 | -0,012 | BR |
| | | 2021 | -0,549 | 0,067 | 0,238 | 3,042 | 3,334 | TB |
| | | 2022 | -0,552 | 0,082 | 0,268 | 3,130 | 1,731 | ZA |
| 9 | **BRAM** | 2019 | -0,227 | -0,008 | 0,073 | 2,701 | 1,815 | ZA |
| | **PT Indo Kordsa Tbk** | 2020 | -0,216 | -0,039 | -0,016 | 2,754 | 1,241 | ZA |
| | | 2021 | -0,214 | 0,021 | 0,123 | 2,618 | 2,241 | ZA |
| | | 2022 | -0,259 | 0,059 | 0,156 | 3,252 | 2,952 | TB |
| 10 | **GDYR** | 2019 | 0,215 | -0,010 | -0,010 | 0,770 | 2,115 | ZA |
| | **PT Goodyear Indonesia Tbk** | 2020 | 0,206 | -0,061 | -0,025 | 0,636 | 1,646 | ZA |
| | | 2021 | 0,171 | 0,020 | 0,021 | 0,676 | 2,034 | ZA |
| | | 2022 | 0,186 | -0,025 | -0,003 | 0,574 | 1,716 | ZA |
| 11 | **MASA** | 2019 | -0,125 | -0,025 | -0,020 | 0,764 | -0,237 | BR |
| | **PT Multistrada Ara Sarana Tbk** | 2020 | -0,113 | 0,063 | 0,060 | 0,985 | 0,898 | BR |
| | | 2021 | -0,156 | 0,096 | 0,124 | 1,087 | 1,265 | ZA |
| | | 2022 | -0,111 | 0,114 | 0,147 | 2,352 | 3,102 | TB |

In contrast, PT Gajah Tunggal Tbk (GJTL) consistently exhibited financial distress throughout the observation period, recording significant losses and market value declines following ownership divestment by major investors (Durrohman, 2023; Hidayah, 2022). This finding supports Feng, Hasan, and Zhang (2020), who noted that ownership structure changes can negatively influence market confidence. PT Indomobil Sukses International Tbk (IMAS) also experienced fluctuating financial conditions yet demonstrated strategic adaptability by entering the electric vehicle market (Aziz, 2023).

Meanwhile, PT Indospring Tbk (INDS) and PT Multi Prima Sejahtera Tbk (LPIN) maintained financially stable positions, supported by export expansion and cost management (Utami, 2021). Conversely, PT Prima Alloy Steel Universal Tbk (PRAS) experienced prolonged

distress (2020–2022) due to declining production and debt restructuring efforts (Handaka, 2023). PT Selamat Sempurna Tbk (SMSM), despite initial challenges, improved its financial health and received multiple corporate awards for resilience and governance (Bisnis Indonesia, 2021). PT Indo Kordsa Tbk (BRAM) and PT Goodyear Indonesia Tbk (GDYR) also recovered from pandemic-related downturns, reflecting the sector's gradual normalization (Kordsa Global, 2022; Prakoso, 2022; Goodyear Indonesia, 2023).

Overall, the Altman Z-Score model proved effective in detecting early signs of financial distress in the automotive industry, though its accuracy depends on contextual factors such as macroeconomic conditions, industrial policy, and corporate governance quality (Alkhatib & Bzour, 2011; Li, 2020). From a theoretical perspective, the results align with Signaling Theory and Financial Distress Theory. According to Spence (1973), companies communicate signals to external stakeholders through financial reports and strategic actions. Firms such as SMSM and INDS provided positive signals through consistent governance and operational stability, reinforcing investor confidence (Connelly, Certo, Ireland, & Reutzel, 2011). Conversely, GJTL and PRAS sent negative signals through declining profitability and debt restructuring, leading to deteriorating market perceptions (Ross, 1977; Supriadi & Yanti, 2020).

From the lens of Financial Distress Theory, firms with lower profitability, weaker working capital management, and declining market equity are more vulnerable to financial instability (Platt & Platt, 2002; Dimitras, Zanakis, & Zopounidis, 2020). However, financial distress should be viewed as an early warning mechanism rather than immediate bankruptcy (Rubiyah & Wahyuni, 2021). Therefore, proactive measures such as product diversification and operational restructuring as seen in ASII and IMAS are essential for sustaining long-term financial resilience.

In conclusion, integrating Signaling Theory and Financial Distress Theory emphasizes that financial statements not only reflect firm performance but also serve as strategic communication tools. Consistent and credible financial reporting strengthens investor trust, enhances corporate reputation, and mitigates future financial distress risks (Morris, 1987; Li, 2020).

**Table 6.** Result *Springate S-Score*

| NO | CODE | YEAR | A | B | C | D | S-SCORE | CATEGORY |
|---|---|---|---|---|---|---|---|---|
| 1 | **ASII** | 2019 | (0,08) | 0,14 | 0,50 | 0,67 | 0,95 | TB |
| | **PT Astra International Tbk** | 2020 | (0,14) | 0,11 | 0,45 | 0,52 | 0,71 | BR |
| | | 2021 | (0,15) | 0,12 | 0,42 | 0,64 | 0,74 | BR |
| | | 2022 | (0,15) | 0,15 | 0,53 | 0,73 | 0,96 | TB |
| 2 | **AUTO** | 2019 | (0,13) | 0,14 | 0,64 | 0,96 | 1,09 | TB |
| | **PT Astra Otoparts Tbk** | 2020 | (0,16) | 0,10 | 0,57 | 0,78 | 0,85 | BR |
| | | 2021 | (0,14) | 0,11 | 0,42 | 0,89 | 0,82 | BR |
| | | 2022 | (0,17) | 0,14 | 0,56 | 1,00 | 1,03 | TB |
| 3 | **GJTL** | 2019 | (0,14) | 0,15 | 0,52 | 0,85 | 0,99 | TB |
| | **PT Gajah Tunggal Tbk** | 2020 | (0,16) | 0,15 | 0,56 | 0,76 | 0,97 | TB |
| | | 2021 | (0,20) | 0,11 | 0,45 | 0,83 | 0,78 | BR |
| | | 2022 | (0,19) | 0,12 | 0,44 | 0,90 | 0,83 | BR |
| 4 | **IMAS** | 2019 | 0,11 | 0,08 | 0,17 | 0,42 | 0,65 | BR |
| | **PT Indomobil Sukses International Tbk** | 2020 | 0,12 | 0,07 | 0,14 | 0,31 | 0,56 | BR |
| | | 2021 | 0,15 | 0,06 | 0,11 | 0,38 | 0,56 | BR |
| | | 2022 | 0,13 | 0,08 | 0,15 | 0,45 | 0,66 | BR |
| 5 | **INDS** | 2019 | (0,28) | 0,11 | 1,88 | 0,74 | 1,58 | TB |
| | **PT Indospring Tbk** | 2020 | (0,30) | 0,09 | 1,61 | 0,58 | 1,27 | TB |
| | | 2021 | (0,29) | 0,15 | 0,98 | 0,85 | 1,15 | TB |
| | | 2022 | (0,27) | 0,15 | 0,87 | 0,94 | 1,14 | TB |
| 6 | **LPIN** | 2019 | (0,40) | 0,06 | 1,69 | 0,27 | 0,99 | TB |
| | **PT Multi Prima Sejahtera Tbk** | 2020 | (0,40) | 0,07 | 1,38 | 0,31 | 0,83 | BR |
| | | 2021 | (0,31) | 0,09 | 1,74 | 0,39 | 1,25 | TB |
| | | 2022 | (0,32) | 0,12 | 1,65 | 0,51 | 1,35 | TB |
| 7 | **PRAS** | 2019 | 0,22 | 0,03 | 0,05 | 0,21 | 0,42 | BR |
| | **PT Prima Alloy Steel Tbk** | 2020 | (0,17) | 0,04 | 0,30 | 0,18 | 0,21 | BR |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2021 | (0,12) | 0,03 | 0,19 | 0,16 | 0,15 | BR |
| | 2022 | (0,06) | 0,00 | 0,01 | 0,06 | (0,03) | BR |
| **8 SMSM** | 2019 | (0,54) | 0,38 | 2,58 | 1,27 | 2,83 | TB |
| **PT Selamat Sempurna Tbk** | 2020 | (0,56) | 0,31 | 2,60 | 0,96 | 2,47 | TB |
| | 2021 | (0,55) | 0,35 | 2,00 | 1,08 | 2,24 | TB |
| | 2022 | (0,55) | 0,37 | 2,28 | 1,12 | 2,51 | TB |
| **9 BRAM** | 2019 | (0,23) | 0,11 | 0,93 | 0,88 | 1,07 | TB |
| **PT Indo Kordsa Tbk** | 2020 | (0,22) | 0,05 | 0,33 | 0,64 | 0,39 | BR |
| | 2021 | (0,21) | 0,16 | 0,75 | 0,90 | 1,13 | TB |
| | 2022 | (0,26) | 0,23 | 1,25 | 1,15 | 1,72 | TB |
| **10 GDYR** | 2019 | 0,21 | 0,13 | 0,24 | 1,16 | 1,25 | TB |
| **PT Goodyear Indonesia Tbk** | 2020 | 0,21 | 0,09 | 0,15 | 0,93 | 0,95 | TB |
| | 2021 | 0,17 | 0,12 | 0,20 | 1,25 | 1,17 | TB |
| | 2022 | 0,19 | 0,08 | 0,13 | 1,39 | 1,08 | TB |
| **11 MASA** | 2019 | (0,13) | 0,08 | 0,49 | 0,71 | 0,71 | BR |
| **PT Multistrada Ara Sarana Tbk** | 2020 | (0,11) | 0,18 | 0,83 | 0,69 | 1,27 | TB |
| | 2021 | (0,16) | 0,25 | 0,89 | 0,89 | 1,54 | TB |
| | 2022 | (0,11) | 0,31 | 1,13 | 1,00 | 1,97 | TB |

Description: BR (bankrupt), TB (not bankrupt).

The comparison between the Springate and Altman Z-Score models demonstrates that the Springate model tends to predict a higher number of bankruptcy cases among automotive companies in Indonesia. For instance, the Springate model classified PT Astra International Tbk (ASII) and PT Astra Otoparts Tbk (AUTO) as bankrupt during 2020–2021, while the Altman model yielded differing outcomes, placing some firms in the grey zone. Similar variations were observed for PT Gajah Tunggal Tbk (GJTL) and PT Indomobil Sukses International Tbk (IMAS), where the Springate model produced alternating predictions of bankruptcy and financial health, reflecting differences in sensitivity toward profitability and liquidity ratios (Ramadhani, 2020; Hidayah, 2022; Aziz, 2023).

Further, PT Prima Alloy Steel Tbk (PRAS) was consistently predicted bankrupt by both models, aligning with reports of financial distress and debt restructuring (Handaka, 2023). Conversely, PT Selamat Sempurna Tbk (SMSM) and PT Goodyear Indonesia Tbk (GDYR) remained financially stable, consistent with their strong performance and recognition in the industry (Prakoso, 2022). Meanwhile, PT Multistrada Arah Sarana Tbk (MASA) and PT Indo Kordsa Tbk (BRAM) exhibited temporary distress during the early pandemic years but recovered thereafter (Puspitasari, 2021; Gewati, 2022).

Overall, the findings indicate that the Springate model exhibits higher sensitivity in identifying potential financial distress compared to the Altman Z-Score, primarily due to differences in ratio composition and weighting. However, such sensitivity may lead to overestimation of bankruptcy risk in firms with short-term liquidity shocks. This suggests the need for model adaptation or hybridization to improve predictive accuracy in the Indonesian automotive sector.

**Table 7.** Result *Springate X-Score*

| NO | CODE | YEAR | X1 | X2 | X3 | X-SCORE | CATEGORY |
|---|---|---|---|---|---|---|---|
| 1 | **ASII** | 2019 | 0,06 | 0,58 | 1,29 | (1,28) | TB |
| | **PT Astra International Tbk** | 2020 | 0,05 | 0,54 | 1,54 | (1,44) | TB |
| | | 2021 | 0,05 | 0,41 | 1,54 | (2,20) | TB |
| | | 2022 | 0,07 | 0,41 | 1,51 | (2,28) | TB |
| 2 | **AUTO** | 2019 | 0,05 | 0,34 | 1,61 | (2,58) | TB |
| | **PT Astra Otoparts Tbk** | 2020 | 0,00 | 0,32 | 1,86 | (2,47) | TB |
| | | 2021 | 0,04 | 0,30 | 1,53 | (2,75) | TB |
| | | 2022 | 0,07 | 0,30 | 1,68 | (2,95) | TB |
| 3 | **GJTL** | 2019 | 0,01 | 0,67 | 1,49 | (0,56) | TB |
| | **PT Gajah Tunggal Tbk** | 2020 | 0,02 | 0,61 | 1,61 | (0,88) | TB |
| | | 2021 | 0,00 | 0,61 | 1,76 | (0,84) | TB |
| | | 2022 | (0,01) | 0,62 | 1,67 | (0,73) | TB |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | **IMAS** | 2019 | 0,00 | 0,82 | 0,77 | 0,35 | BR |
| | **PT Indomobil Sukses International Tbk** | 2020 | (0,01) | 0,78 | 0,76 | 0,17 | BR |
| | | 2021 | (0,01) | 0,75 | 0,72 | (0,01) | TB |
| | | 2022 | 0,01 | 0,75 | 0,75 | (0,04) | TB |
| 5 | **INDS** | 2019 | 0,04 | 0,10 | 5,83 | (3,93) | TB |
| | **PT Indospring Tbk** | 2020 | 0,02 | 0,10 | 6,17 | (3,86) | TB |
| | | 2021 | 0,04 | 0,19 | 2,88 | (3,42) | TB |
| | | 2022 | 0,05 | 0,27 | 2,53 | (3,03) | TB |
| 6 | **LPIN** | 2019 | 0,09 | 0,09 | 13,0 | (4,25) | TB |
| | **PT Multi Prima Sejahtera Tbk** | 2020 | 0,02 | 0,11 | 9,05 | (3,82) | TB |
| | | 2021 | 0,08 | 0,09 | 7,26 | (4,18) | TB |
| | | 2022 | 0,08 | 0,10 | 5,19 | (4,12) | TB |
| 7 | **PRAS** | 2019 | (0,03) | 0,61 | 0,60 | (0,71) | TB |
| | **PT Prima Alloy Steel Tbk** | 2020 | (0,00) | 0,69 | 2,38 | (0,37) | TB |
| | | 2021 | (0,00) | 0,70 | 1,85 | (0,30) | TB |
| | | 2022 | (0,06) | 0,76 | 1,38 | 0,30 | BR |
| 8 | **SMSM** | 2019 | 0,19 | 0,33 | 4,64 | (3,29) | TB |
| | **PT Selamat Sempurna Tbk** | 2020 | 0,14 | 0,33 | 5,76 | (3,11) | TB |
| | | 2021 | 0,17 | 0,25 | 4,18 | (3,68) | TB |
| | | 2022 | 0,19 | 0,24 | 4,43 | (3,81) | TB |
| 9 | **BRAM** | 2019 | 0,05 | 0,27 | 2,90 | (2,99) | TB |
| | **PT Indo Kordsa Tbk** | 2020 | (0,01) | 0,27 | 2,56 | (2,73) | TB |
| | | 2021 | 0,09 | 0,28 | 1,99 | (3,12) | TB |
| | | 2022 | 0,11 | 0,24 | 2,42 | (3,46) | TB |
| 10 | **GDYR** | 2019 | (0,01) | 0,56 | 0,61 | (1,04) | TB |
| | **PT Goodyear Indonesia Tbk** | 2020 | (0,06) | 0,61 | 0,65 | (0,54) | TB |
| | | 2021 | 0,02 | 0,60 | 0,71 | (0,99) | TB |
| | | 2022 | (0,03) | 0,64 | 0,71 | (0,57) | TB |
| 11 | **MASA** | 2019 | (0,02) | 0,57 | 1,78 | (0,96) | TB |
| | **PT Multistrada Ara Sarana Tbk** | 2020 | 0,08 | 0,50 | 1,51 | (1,78) | TB |
| | | 2021 | 0,10 | 0,48 | 1,56 | (2,01) | TB |
| | | 2022 | 0,11 | 0,30 | 1,41 | (3,12) | TB |

Description: BR (bankrupt), TB (not bankrupt).

Based on the analysis presented in Table 7, the Zmijewski model and advancement of earlier bankruptcy prediction models indicates that most automotive companies were not classified as bankrupt during the observed periods. Only three firm-year observations were identified as financially distressed: PT Indomobil Sukses International Tbk (IMAS) in 2019–2020 and PT Prima Alloy Steel Tbk (PRAS) in 2022. According to Rudianto (2013), the Zmijewski model places substantial emphasis on leverage ratios, particularly total debt, as a determinant of financial distress. However, empirical findings in the Indonesian automotive sector suggest that these firms remained solvent, despite facing temporary financial challenges. This discrepancy implies that the Zmijewski model may have limited predictive accuracy in industries with high asset intensity and cyclical financing structures, such as automotive manufacturing. Further calibration or contextual adjustment may therefore be required to enhance the model's reliability in emerging markets.

Nevertheless, the results of this study confirm that all three models, Altman Z-Score, Springate, and Zmijewski, can predict financial distress to varying degrees of accuracy. Among them, the Zmijewski model demonstrates the highest predictive reliability, followed by the Springate and Altman Z-Score models. Consequently, the findings support the acceptance of Hypothesis 1 (H1), Hypothesis 2 (H2), and Hypothesis 3 (H3), which propose that each of the three models can be applied to predict bankruptcy risk in Indonesian automotive companies, with the Zmijewski model providing the most accurate classification under current economic conditions.

## Conclusion

This study aimed to evaluate the predictive accuracy of three bankruptcy prediction models Altman Z-Score, Springate, and Zmijewski in identifying financial distress among automotive sector companies in Indonesia. The findings reveal significant variation in the predictive performance of each model. First, the Altman Z-Score model demonstrated a relatively low accuracy rate of 22% with a type error of 34%, indicating limited reliability in the automotive context. This reduced accuracy may be attributed to the diminishing significance of the *Earnings Before Interest and Taxes to Total Assets* ratio, which tends to underrepresent financial distress when firms maintain efficient asset utilization and positive profitability (Rudianto, 2013). Although the model remains widely applied, its precision appears inconsistent across different industries (Primasari, 2017; Huda et al., 2019). Second, the Springate model achieved a higher accuracy level of 61% and a type error of 38%, suggesting moderate reliability. The model's focus on *Working Capital to Total Assets* underscores the importance of liquidity management and operational efficiency in preventing financial distress. These findings are consistent with Sari (2015) and Widiasmara (2019), who highlight the Springate model's effectiveness, albeit with limitations in sensitivity and specificity.

Finally, the Zmijewski model yielded the highest accuracy at 93% with a type error of 7%, establishing it as the most robust and reliable model among those tested. The model's emphasis on leverage and profitability ratios offers a more realistic reflection of financial distress dynamics within capital-intensive sectors such as automotive manufacturing. This result aligns with prior research by Rachmawati et al. (2022), who confirmed the Zmijewski model's superior predictive performance. However, industry-specific factors and temporal variations may still influence their generalizability (Wahyuni, 2021). Overall, the study concludes that while all three models are applicable in predicting financial distress, their effectiveness varies by context. The Zmijewski model is the most accurate for Indonesia's automotive industry, followed by the Springate and Altman models. These findings reinforce prior empirical evidence that bankruptcy prediction models should be contextually calibrated to reflect sectoral characteristics, financial structures, and macroeconomic conditions (Altman et al., 2017; Pindado et al., 2008). Future research is encouraged to develop hybrid or industry-specific models that integrate financial and non-financial indicators for enhanced predictive accuracy.

Despite providing valuable insights, this study has limitations. First, the analysis was confined to automotive sector companies listed on the Indonesia Stock Exchange (IDX) over a specific observation period, which may limit the generalizability of the findings to other industries or economic cycles. Second, the study relied exclusively on quantitative financial ratios derived from audited financial statements, while non-financial factors such as management quality, market sentiment, and macroeconomic shocks were not incorporated. These qualitative dimensions could significantly influence a firm's financial distress status but remain unaccounted for within traditional bankruptcy prediction models. Third, the study did not evaluate the impact of external economic disruptions, such as the COVID-19 pandemic or fluctuations in exchange rates and commodity prices, which might alter firms' financial stability and affect model performance.

Therefore, future research is recommended to expand the analytical scope by incorporating a larger cross-sectoral sample and a longer observation horizon to enhance the external validity of the results. Subsequent studies could also develop hybrid predictive frameworks that integrate both financial and non-financial indicators, such as corporate governance, ESG performance, and macroeconomic variables, to improve predictive robustness and contextual adaptability. Additionally, employing machine learning or artificial intelligence-based approaches may provide dynamic and data-driven improvements over conventional statistical models, enabling more precise and timely predictions of corporate financial distress in emerging markets, such as Indonesia.

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