THE ACCURACY ANALYSIS OF FINANCIAL DISTRESS MODEL A BENCHMARK OF OPERATIONAL PERFORMANCE AND FIRMS' INVESTMENT

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ABSTRACT

This study aims to find out the difference in the level of model accuracy among the Modified Altman Prediction (Z-Score), Springate (S-Score), and Zmijewski prediction models in predicting financial distress as a model of predicting operational Management and investment performance benchmarks in Transportation sub-sector firms in the Indonesian Stock Exchange (IDX) for the 4-period time. This study is a quantitative descriptive approach. The sampling technique is purposive sampling. This study utilizes sample data from the IDX, specifically www.idx.co.id, as well as the official websites of each firm. The results demonstrate that the Modification Altman Z-Score model can predict financial distress or potential bankruptcy by correctly assigning as many as 26 out of 48 samples, achieving an accuracy rate of 54.17%. The Springate S-Score model can predict financial distress or potential bankruptcy by assigning as many as 24 samples from 48 samples with an accuracy rate of 50%. The Zmijewski model was able to predict financial distress or potential bankruptcy with the highest accuracy level among the models used in this study, achieving an accuracy rate of 70.83% on 34 out of 48 samples. The conclusion from the three model bankruptcies is that the Zmijewski model is the most suitable for firms to use if they want to attract potential investors. It is used to predict financial distress and operational performance, as well as to inform firms' investment decisions. The findings of this study suggest that additional financial distress prediction models, such as Ohlson, Grover, and others, can be utilized to compare and contrast the yields of financial distress analysis.

INTRODUCTION

Business potential increasingly attracts investment, especially in the development of the digital industry era 4.0, which is currently experiencing rapid growth (Botti et al., 2021). This map illustrates intense business competition among firms worldwide, particularly in Indonesia. All efforts are made to be the best. Effective management strategies and processes are key to success in today's industry, encompassing human resource management, marketing management, production management, and financial Management (APUS, 2024). Strategy and Management of operations and operational sectors are crucial management functions for an organization or firm. Operational Management is developing very rapidly. This is due to the emergence of many innovations in technology that are applied in business practices; therefore, firms in the world are starting to look at and try to make aspects of operational Management and operations a strategic tool to compete and outperform their competitors (Füller, Hutter, Wahl, Bilgram, & Tekic, 2022).

In line with the firm's efforts to sharpen the service quality, especially in responding to the needs of effective operational Management of the firm in implementing programs and efficient in Management and productive in achievement, various potentials will be mobilized using limited resources owned by optimizing working capital and investment in capital goods according to the business competency entered (ICAI, 2021), considering that the success of the firm's operations will be tested by the final achievement of each financial report closing period. Transportation service firms are one type of business that is encouraged to continue investing in various promising areas, both domestically and internationally, including in Indonesia.

In the context of sustainability, the transportation sector is the business sector that experienced the deepest contraction out of 17 business sectors recorded by the Biro Pusat Statistik. It was recorded that, during the period from April to July 2020, the transportation and warehousing sector experienced a 30.84 percent decrease, and the growth rate of the

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transportation sector is expected to remain slow until the end of this year (Ramli & Jatmiko, 2020). Furthermore, the transportation, warehousing, and logistics sectors in 2022 experienced the highest growth, reaching 19.87%. Especially after the COVID-19 pandemic, the transportation and logistics sector has been one of the businesses experiencing high growth in recent years (Supply Chain Indonesia, 2024).

Among these potentials, it encourages every firm to create various innovations to attract the attention of consumers, which will ultimately increase the business profits. In the situation and conditions of the last few years because of implicated the Covid-19 Pandemic, the investment atmosphere felt by various firms is not the same including some enterprises that have decided to withdraw from the transportation sector competition considering that the firm's operational capabilities are not able to move up significantly amidst business competition, even quite a few of them have started to predict their financial condition by predicting bankruptcy (financial distress) as a method to ensure business capacity and optimize the business operational achievements in the future which of course is expected to attract investors to invest in this transportation sector. The calculation for the financial distress model analysis is classified into several models commonly used in previous research. For instance, Robiansyah et al. (2022) found that the Altman model is the most effective for predicting bankruptcy in manufacturing companies, outperforming the Springate, Zmijewski, and Grover models. In contrast, Meilawati et al. (2023) found that the Zmijewski model is the most suitable choice for predicting bankruptcy in the hotel, restaurant, and tourism subsectors, when compared to the Springate and Zmijewski models. For this reason, this study aims to find out the differences in the level of model accuracy among the Modified Altman Prediction (Z-Score), Springate (S-Score), and Zmijewski prediction models in predicting financial distress as a model of predicting operational Management and investment performance benchmarks in Transportation sub-sector firms in the Indonesian Stock Exchange (IDX).

LITERATURE REVIEW
Operational Management Concept
Operational Management is needed in a business to control operational activities. A business requires supervision of several key elements that support its activities, including finance, marketing, and production, which are integral to operational activities (Porter, 2011). Broadly speaking, operational Management is a strategy used in the arrangement and administration of business operations practices to create maximum efficiency in a corporation (Kothari, 2025). Handoko (2019, hal. 3) argues that operations production management works to optimally carry out the utilization of resources (called production factors), such as raw materials, machines, labor, equipment, and so on, to transform materials and labor into diverse products or services. Initially, it involves the utilization of resources and then includes the processing phase til it creates a product, either of finished goods or services. To ensure that nothing hinders the operational process, a manager must be supervised and responsible for that division. A framework is needed that can categorize and formulate decisions in various operations.

Financial Concepts and Bankruptcy Analysis (Financial Distress)
Myers and Pogue (1974) stated that Management must ensure that corporate finances are used in accordance with the plan and are consistent with business goals. The most essential of the supply elements in operational Management is finance. Then, used to produce quality goods and services (Akintoye, Hardcastle, Beck, Chinyio, & Asenova, 2003). Appropriate finances facilitate the process of creating optimal products and services. Financial management arrangements, especially cash management, are crucial in the context of inventory turnover; however, they do not eliminate the risk of running out of inventory, which can result in future losses for the firm (Nasution, 2023). In addition, with good financial Management, the firm's operations and investments will align with the planning that has been set, both in the short and long term.

The operational movement of firm investments can be measured and detected through an appropriate and accurate financial analysis model that the firm can use, including bankruptcy analysis (Financial Distress). According to Platt and Platt (2002), financial distress is defined as a condition of decline in a firm's financial position before bankruptcy or liquidation. Lau (1987) revealed that the deterioration in financial conditions stems from the composition of the balance sheet, specifically when the total assets are smaller than the amount of the firm's debt, rendering the business unable to pay its obligations (Mentariningrum & Prasetiono, 2022). Elloumi and Gueyié (2001) stated that a firm's condition of financial distress is characterized by two consecutive years of negative Earnings Per Share (EPS). Therefore, firms must prevent or minimize the event of financial distress by reviewing financial reports and conducting a financial distress analysis.

Financial distress indicators that firm Management (internal parties) must pay attention to are related to the efficiency and effectiveness of its operations, as stated by Hartanto (1984), are: (1) A decrease in sales volume because of consumer moves, demands, or tastes. (2) Production costs are worked up. (3) Competition in the business climate rises. (4) Business expansion of a failed. (5) The collecting receivables function is ineffective. (6) Lack of contributions or funding facilities (credit). (7) Dependence on corporate receivables is high. The indicators that external parties must pay attention to include: (1) a decrease in dividends distributed to shareholders. (2) Losses corporation, and a continuous decline in the point of lower. (3) One or more business units which has stopped their operational activities. (4) Layoffs. (5) Resignation of top executives. (6) Decrease in the capital market of stock prices (Teng, 2002).

Financial Distress Analysis Model
Elements to express bankruptcy prediction analysis can use a model. This model must ensure that the construction meets the structure, form, and content, and has meaning, with parameters limited to specific measures in decision-making (Husain, 2019). Several financial distress analysis models that are pretty popular and used in this study are:
− Altman Z-Score; i.e., with the name 'Altman Model Analysis' (1968); calculated with the equation formula adhered:
$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \qquad \text{... (1)}$$

Explanation:

X_1 is Working Capital divided by Total Assets

X_2 is Retained Earnings (RE) divided by Total Assets

X_3 is Earnings before Interest and Taxes (EBIT) divided by Total Assets

X_4 is the Book Value of Equity divided by the Book Value of Total Debt

X_5 = Sales to Total Assets (TA)

The assumptions: (i) If the Z index score is < 1.81, then the firm is experiencing financial distress; (ii) if the Z index score is > 2.99, then the firm is not experiencing financial distress; (iii). If the index score Z is between 1.81 and 2.99, then it falls within the grey area (the firm is experiencing minor financial problems and has a probability of experiencing financial distress); and (iv) the cut-off value for this index is 2.675.

− Modified – III, Altman Model Analysis (Altman, Hartzell, & Peck, 1998); in this model, Altman eliminates the variable X_5 (sales/total assets) because this ratio varies significantly across industries with different asset sizes. The calculated equation formula is:

$$Z" = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \qquad ... (2)$$

− Altman (1968) is a model constructed by re-evaluating and redesigning the Altman Z-Score model. Altman (1968) utilized a sample based on the Altman Z-Score model in 1968 by adding thirteen financial ratios. The calculated equation formula is:

$$G - Score = 1.650X_1 + 3.404X_2 + 0.016ROA + 0.057 \qquad ... (3)$$

Explanation:

X_3 = Return on Assets (ROA)

The assumptions: (i) if a firm gets a G-Score <- -0.02, it is an enterprise that will or has experienced financial distress; and (ii) if a firm gets a G-Score ≥ 0.01, it is categorized as a firm that is not experiencing financial distress.

− Gordon L.V. Springate (1978) is a model that uses the same method as Altman. Springate offers four ratios that are guaranteed to differ between firms in distress and those that are not. The calculated equation formula is:

$$S = 1.03A + 3.07B + 0.66C + 0.4D \qquad ... (4)$$

A is Working Capital divided by TA

B is EBIT divided by TA

C is Earnings before Taxes (EBT) to Current Liabilities (CL)

D is Sales to TA

The assumptions: (i) the cut-off value criteria for the Springate model is 0.861; if the score is < 0.861, it indicates that the corporation will experience financial distress; and (ii) if the score is > 0.861, it indicates that the corporation will not impress financial distress

− Mark E. Zmijewski (1984) is a model that utilizes the liquidity ratio analysis, leverage, and measures a firm's performance. F-Test indicators against the ratio of group 39 rate of return, liquidity, turnover, fixed payment coverage, leverage, firm size, trends, and stock return volatility indicate significant differences among healthy and unhealthy firms. The calculated equation formula is:

$$Z = -4.3 - 4.5X_1 + 5.7X_2 - 0.004X_3 \qquad ... (5)$$

Explanation:

X_1 is Earnings after Tax (EAT) to TA

X_2 is Total Debt to TA

X_3 is Current Assets to CL

The assumptions: (i) the criteria in this model are that if the score obtained is ≥ 0 (zero), then the firm will indicate financial distress; and (ii) if the score obtained is ≤ 0 (zero), then the firm has no potential to indicate financial distress.

Calculating Accuracy Level

To evaluate which financial distress model is the best predictor among the models to be used, a comparison between predictions and sample categories is carried out on all existing samples after all samples have been calculated, the results of a summary of correct and incorrect predictions are obtained, and through the summary of forecasts, the accuracy level of each model can be determined. The accuracy rate indicates a high percentage of the model's predictions that are correct for all existing firms. The calculated equation, as an accuracy level formula, adheres:

$$= 100 \frac{\sum_i x_{ii}}{n} \qquad ... (6)$$

(Galdi & Tagliaferri, 2019)

In the calculation of each model, there is always a possibility of prediction error. Therefore, in calculating the accuracy level of each model, the error level or error rate of each model is also considered, with the equation:

− Error Type I is an error that prevails if the model predicts that the company is experiencing distress when, in fact, the corporation is not experiencing distress.

$$Error\ Type - I = \frac{Number\ of\ error\ type-I}{Number\ of\ samples} x100\% \qquad ... (7)$$

− Error Type-II is an error that prevails if the model predicts that the company is not experiencing distress when, in fact, the corporation is experiencing distress.

$$Error\ Type - \text{II} = \frac{Number\ of\ error\ type-\text{II}}{Number\ of\ samples}\,x100\% \qquad ...\ (8)$$

<div align="center">(Sun, Li, Huang, & He, 2014)</div>

Relevant Research

Research conducted by Robiansyah *et al.* (2022) analyzed the comparison of the feasibility level of the bankruptcy prediction model when it is taken to foresee the company, with the represent yields that of the four models studied, to predict the bankruptcy of manufacturing firmscompanies registered on the Indonesia Stock Exchange the Springate model cannot be used, because it has a significance probability is 0.175 (greater than 0.05). Research conducted by Meilawati *et al.* (2023) analyzed the comparison of Altman, Springate, and Zmijewski Models in Predicting Bankruptcy in Hotel, Restaurant, and Tourism sub-sectors Companies for the Period 2017-2021, with the findings arguing that the Altman, Springate, and Zmijewski models are very different from each other in predicting bankruptcy. The Zmijewski model is the most accurate, with an accuracy rate of 94.5 percent.

MATERIALS AND METHODS

Based on the research purpose, this study is a quantitative descriptive approach, i.n, research conducted to determine the value of a variable (Sugiyono, 2023, hal. 11). This study was conducted by accessing data on the Indonesia Stock Exchange (IDX), i.e., www.idx.co.id and the official website of each corporation. The subject research is firms in the Transportation sub-sector registered at IDX for utilization (4 a four-period time. Based on the data type, this study is categorized as secondary, specifically research that utilizes numerical data (quantitative). By its form, quantitative data can be processed using mathematical calculations and/or statistical analysis (Abdullah et al., 2022). The sampling method is purposive.

Table 1. Determination of Population and Sample of Transportation Sub-Sector Firms

Total Population		**45**
Criteria	Transportation sub-sector firms that do not publish complete financial reports for four periods	(20)
	Transportation sub-sector firms listed on the Indonesia Stock Exchange (IDX) that publish Financial Reports in USD currency	(13)
Number of Firm Samples		**12**
Criteria	Sample Used 12 x 4 (Period)	48
	Category 0 (Distress) of Firms*	19
	Category 1 (Non Distress) of Firms*	29

*)*Firm Observation Data Details* in Appendix
Source: Author's Ellaborated (2025)

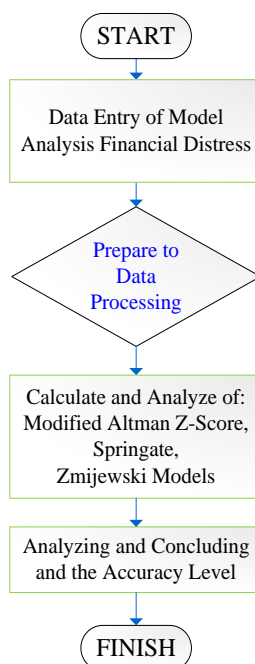To establish that researchers can analyze easily, researchers use the adhere phases:

Figure 1. Flowchart of Financial Distress Prediction Model

This research is comparative because the researcher aims to identify the differences in model accuracy levels among the Modified Altman (Z-Score), Springate (S-Score), and Zmijewski prediction models in predicting financial distress. The

goal is to establish benchmarks for assessing the quality of a firm's operations and investments.

RESULTS AND DISCUSSIONS

After determining the predetermined sample, transportation sub-sector companies were identified that met the research criteria. The following is a list of firms that were used as samples in this study:

Table 2. Sample Data Category 0 (Distress) and 1 (Non-Distress)

Data Observation	Issuer Code	Period of		Data Observation	Issuer Code	Period of		Issuer Code	Period of
1	CMPP	y		1		y	20	SAFE	y
2		y-1		2	AKSI	y-1	21		y-3
3		y-1		3		y-2	22	SDMU	y-3
4	LRNA	y-2		4		y-3	23		y
5		y-3		5		y	24	TMAS	y-1
6		y		6	ASSA	y-1	25		y-2
7	MIRA	y-1		7		y-2	26		y-3
8		y-2		8		y-3	27		y
9		y-3		9		y	28	WEHA	y-1
10		y-1		10		y-1	29		y-2
11	SAFE	y-2		11	BIRD	y-2	y = current period			
12		y		12		y-3	y-1 = period of 1 year ago			
13	SDMU	y-1		13		y-2	y-2 = period of 2 years ago			
14		y-2		14	CMPP	y-3	y-3 = period of 3 years ago			
15		y		15	LRNA	Y				
16	TAXI	y-1		16		y				
17		y-2		17	NELY	y-1				
18		y-3		18		y-2				
19	WEHA	y-3		19		y-3				

Source: Author's elaboration from IDX Data (2025)

Descriptive data is used to describe or explain a summary of research variables without connecting or comparing them with other variables.

− Calculation of Accuracy and Error Modified Altman Z-Score

Table 3. Modified Altman Z-Score Model (Error Type)

Recapitulation	Identification	Prediction		Total
		Distress	Non Distress	
Fact	Distress	12	7	19
	Non Distress	15	14	29
	Total	**27**	**21**	**48**
Accuracy Level Test Results				
Accuracy Scores	Accuration	54.17%		
	Error Type-I	14.58%		
	Error Type-II	31.25%		

Source: Author's Calculated (2025)

Table 3 shows that, out of a total of 19 samples in category 0 (distress), the Modified Altman Z-Score model predicts 12 samples experiencing financial distress. In comparison, seven other samples do not exhibit financial distress. Therefore, there is an error in this model that predicts that seven samples do not experience financial distress. Meanwhile, from the 29 samples in category 1 (non-distress), the Modified Altman Z-Score model predicts that 14 samples do not experience financial distress, while 15 other samples indicate financial distress. Therefore, there is an error in this model, which predicts that 15 samples will experience financial distress when, in reality, this is not the case. Therefore, it can be inferred that the Modified Altman Z-Score model yields correct predictions for 26 samples and incorrect predictions for 22 samples. The accuracy level of the Modified Altman Z-Score model is 54.17%. The error rate of this model for error type I is 14.58%, while the error rate for error type II is 31.25%.

− Calculation of Accuracy and Error Type of Springate S-Score Model

Table 4. Springate S-Score Model Error Type

Recapitulation	Identification	Prediction		Total
		Distress	Non Distress	
Fact	Distress	19	-	19
	Non Distress	24	5	29
	Total	**43**	**5**	**48**
Accuracy Level Test Results				
Accuracy Scores	Accuration	50.00%		
	Error Type-I	0.00%		

Recapitulation	Identification	Prediction		Total
		Distress	Non Distress	
	Error Type-II	50.00%		

Source: Author's Calculated (2025)

Table 4 shows that, out of a total of 19 samples in category 0 (distress), the Springate S-Score model predicts 19 samples experiencing financial distress, and no samples are not experiencing financial distress. Therefore, there is no error in this model in predicting samples in category 0 (distress). Meanwhile, from the 29 samples in category 1 (non-distress), the Springate S-Score model predicts that five samples do not experience financial distress, while 24 other samples indicate financial distress. Therefore, there is an error in this model, as it predicts that 24 samples will experience financial distress; in reality, this is not the case. Therefore, it can be inferred that the Springate S-Score model yields correct predictions for 26 samples and incorrect predictions for 22 samples. The accuracy level of the Springate S-Score model is 50%. There are no errors in this model for error type I, while error type II occurs at a rate of 50%.

− Calculation of Accuracy and Error Type of the Zmijewski Model

Table 5. Zmijewski Model Error Type

Recapitulation	Identification	Prediction		Total
		Distress	Non Distress	
Fact	Distress	9	10	19
	Non Distress	4	25	29
	Total	**13**	**35**	**48**
Accuracy Level Test Results				
Accuracy Scores	Accuration	70.83%		
	Error Type-I	20.83%		
	Error Type-II	8.33%		

Source: Author's Calculated (2025)

Table 5 shows that, out of a total of 19 samples in category 0 (distress), the Zmijewski model predicts that nine samples will experience financial distress. In comparison, the remaining 10 samples do not exhibit financial distress. Therefore, there is an error in 10 samples of this model in predicting samples in category 0 (distress). Meanwhile, from 29 samples in category 1 (non-distress), the Zmijewski model predicts that 25 samples do not indicate financial distress, and four other samples experience financial distress. Therefore, there is an error in this model, as it predicts that four samples will experience financial distress, whereas in reality, this is not the case. The Zmijewski model yields correct predictions for 34 samples and incorrect predictions for 14 samples. The accuracy level of the Zmijewski model is 70.83%. The error rate of this model for error type I is 20.83%, while the error rate for error type II is 8.33%.

− Summary of Accuracy and Error Level Test Yields

Table 6. Accuracy and Error Level Test Yields (Recapitulation)

Test Result Scoring	Model Analysis		
	Altman Modified	Springate	Zmijewski
Accuracy Level	54.17%	50.00%	70.83%
Error Type-I	14.58%	0.00%	20.83%
Error Type-II	31.25%	50.00%	8.33%

Source: Author's Calculated (2025)

The yields of the study conducted on transportation sub-sector firms registered on the Indonesia Stock Exchange over four periods indicate that the Altman Modified Z-Score prediction method ranks second as a suitable method for measuring financial distress in transportation sub-sector firms, with an accuracy rate of 54.17% and an error rate below 35%. In contrast, the highest accuracy rate is obtained from the Zmijewski prediction method calculation, while the Springate method yields the lowest accuracy rate among the three. These findings are consistent with those of Robiansyah *et al.* (2022), who concluded that the Springate model is not suitable for predicting corporate bankruptcy, as it has no statistically significant effect on manufacturing companies. Additionally, it states that the Zmijewski model is the most accurate, producing a high level of accuracy of 94.5% in hotels, restaurants, and tourism sub-sector companies (Meilawati, Damayanti, & Ilhami, 2023). The Zmijewski model is widely exploited to measure firm performance and investments utilizing company financial ratio analysis.

CONCLUSIONS
This study investigates to wants to find out the differences in the level of model accuracy among the Modified Altman Prediction (Z-Score), Springate (S-Score), and Zmijewski prediction models in predicting financial distress as a model of predicting operational Management and investment performance benchmarks from Transportation sub-sectors firms registered on the Indonesia Stock Exchange (IDX) for the 4-periods, it can be drawn: (1) From the assessment of the Altman Modified Z-Score model analysis, it accurately predicts 26 samples out of 48 existing samples so that it has an accuracy level of 54.17%. (2) From the assessment of the Springate S-Score model analysis, it accurately predicts 24 samples out of 48 existing samples, so that it has an accuracy level of 50%. (3) While the assessment of the Zmijewski model analysis

accurately predicts 34 samples out of 48 existing samples, it has an accuracy level of 70.83%. The conclusion from three model bankruptcies is that the Zmijewski model is the most appropriate for firms to use if they want to attract potential investors to invest, and is used to determine the prediction of financial distress as a method for predicting the benchmark for the quality of operational and investment companies in the Transportation sub-sectors firms registered on the IDX for the 4-periods. This study has the drawback of producing the lowest model accuracy percentage compared to the previous studies referred to, and also, the total number of samples observed to predict the three models tested was small. This study suggests that additional financial distress prediction models, such as Ohlson, Grover, and others, can be used to compare and contrast the results of financial distress analyses. The sample should be expanded in future studies.

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