Analysis of Bankruptcy Prediction With Altman Z-Score, Springate and Zmijewski Models Based Engineering Science
(Case study at Garuda Indonesia Airline, Period Years of 2014-2017)

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Abstract. The purpose of this reseach is to analysis and to make a bankruptcy prediction of the Garuda Indonesia listed on Indonesian Stock Exchange, and to find out what the best model used in a bankruptcy prediction of company. Reseach method based on purposive sampling. The population of this reseach is a numbers of company financial reporting listed on Indonesian Stock Exchange, and the sample obtained from period years of 2014 to 2017. The analysis of technical data used is descriptive analysis with a helping microsoft excel software. The reseach finding, that based on Altman Z-Score, and Springate prediction model based engineering science, Company have experienced a potency of bankruptcy since 2014 till 2017. Meanwhile Zmijewski prediction model based engineering science company has experienced a potency of bankruptcy in 2014 and 2017, whereas in 2015 and 2016, company is classified as a healthy company. Based on result of the third models analysis mentioned, Zmijewski model is a better in bankruptcy prediction of company.

Key Words: Bankruptcy Prediction, Z-Score Altman, Springate, Zmijewski Models, Engineering Science.

Introduction

The Dynamics of a company finance performance which is influenced by a growing of business environment turbulence and stricting of an increasing competition. The alteration in an environment of business airline is extremely effected by politics, economics, social and information technology dynamic. The company that has no capabilities to adapt on environment change will have a business problem and investment risk. The company will always face some risk, especially business risk, and the risk country will creat a finance distress and bankruptcy. According to Ahmad Rodoni (2014: 189), From the financial aspect, three circumstances can cause financial distress, namely the factor of capital insufficiency or lack of capital, the amount of debt and interest burden, and suffering losses. While the causes of financial pain from macroeconomic factors are uncertainty of a country’s economic conditions such as inflation and foreign exchange rates. Fifrianti and Santosa (2018), stated that condition of finance distress could be identified earlier, before problem appears by using an early warning system model.

Many researchers conducted a bankruptcy research, some of them have developed prediction model based engineering sciences by purpose to assist some potential investors and creditors in making choice of company where they should invest their capital, in order to protect from risk or finance distress. Some of prediction model based engineering sciences issued by Altman (1968), Springate (1978), Ohlson (1980), and Zmijewski (1983).

Development of aviation services industries in Indonesian, notably for commercial aviation schedule since the deregulation of aviation transportation was issued on 1999 by government. The aviation industries business, in putting into operation must have a big capital, and have a capabilities to adapt on changing of business environment, and it also has to follow a changing of high technology in running business as one of its competitive advantage and customers satisfaction.

Garuda Indonesia as a national and international commercial aviation and also constitutes one of Indonesian state owned enterprises, in period years of 2014 – 2017, in operating its business has a fluctuation income where company has imbalance in faring its operating. It has a total loss as US$ 371.97 million, in year 2014, and got a profit as US$ 77.97 million in year 2015, and the company have experienced a profit declining up to become as US$ 9.36 million in year 2016 and in the year 2017, the company experienced a net loss as US$ 213.38 million. All information based on financial report of company which is listed on Indonesian Stock Exchange (www.idx.com).

Based on information mentioned above, how important it is for researcher to know a potency of company bankruptcy, so the researcher conducts a research at Garuda Indonesia as one of Indonesian state owned enterprises, for period years of 2014 to 2017, by using Altman Z-Score, Springate, dan Zmijewski models.
Literature Review

Bankruptcy

The bankruptcy is a condition when the company has insufficient funds to run its business or failure of the company in running its operations to generate profit. Venkataramana et al. (2012) states that Bankruptcy is a situation where liabilities exceed assets in a company, it generally occurs due to lack of capital, has no sufficient cash, the sources have properly not utilized, The management activities are inefficient, sales growth is declining, and the market situation deteriorates. Furthermore, Onakoya & Olotu (2017) stated that bankruptcy is, when a company has no capabilities to earn sufficient revenue to cover its costs, in this case, such a company has a negative economic value. Drescher (2014: 25), said that financial distress is the final stage of a liquidity crisis and potentially included in the bankruptcy stage. According to Musthafa (2017: 202), financial difficulty is a condition in which a company is unable to meet its financial obligations, both short and long term.

Setiadi (2011) identified factors that make a bankruptcy of company can be classified into two factors, namely: Internal factors, where management has no capabilities to run its business efficiently and can not fulfil their obligations, there is an inefficiency and imbalance amount of capital owned to cover total debts recently, and with the amount of debt will reduce a company profits. Fraud of management will also create a bankruptcy of company. External factors, alteration in customer demand that should be fulfilled by company, the suppliers who cannot meet raw material standard, excessive of receivables inventory, have a poor relationships with debtors, strict of business competition and global economic conditions that must be a consideration.

There are several tools used to predict the bankruptcy of a company. The bankruptcy predictors resulting from various studies conducted by experts who focus on bankruptcy at various companies in the world, there are at least three (3) models that can be used to predict bankruptcy and consist of Altman Z-Score, Springate, Zmijewski Model, Subrahmanyan, et.al (2010).

The Altman Model (Z-Score)

The first bankruptcy prediction model based engineering science was introduced by Altman (1968), known as Altman Z-Score. This model has been widely used and still being relevant to predict a company whether it is bankrupt, in grey area or healthy. Altman, et al.(2017). In 1995, Edward Almant later modified the model, so that it can be used for predicting bankruptcy of manufacturing and non-manufacturing companies.

The modification of Altman Z-Score completely removes X5 variable (Sales to Total Assets), because this ratio has many variation and asset size among industries. The following Z-Score equation showed after modification.

\[
Z = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4
\]

Where
- \(Z\) : Bankruptcy index
- \(X1\) : Working capital / total assets
- \(X2\) : Retained earnings / total assets
- \(X3\) : Earnings before interest and taxes / total assets
- \(X4\) : Market value of equity / total liabilities

The classification of company based on Altman Z-score model, namely:
- If value of \(Z < 1.1\), is classified as a bankruptcy company.
- If value of \(1.1 < Z < 2.6\), is classified as a grey area company
- If value of \(Z > 2.6\), is classified as a healthy company.

The Springate Model (S-Score)

This model was developed in 1978 by the Gorgon L.V. Springate. By following the procedures developed Altman, Springate using step-wise Multiple Discriminate Analysis (MDA) to make a choice of four rasio from 19 popular financial ratios that can distinguish companies are in poor zone or safe zone. The following Springate equation showed, as follow.

\[
S = 1.03A + 3.07B + 0.66C + 0.4D
\]

Where
- \(A\) : Working Capital to Total Assets
- \(B\) : Net Profit Before Interest and Taxes to Total Assets
- \(C\) : Net Profit Before Taxes to Current Liabilities
- \(D\) : Sales to Total Asset

The limitation values used to know what the company is in a bankruptcy or a healthy zone, are:
• If value of Springate > 0.862, is classified as a healthy company.
• If value of Springate < 0.862, is classified as a bankruptcy company.

The Zmijewski Model (X-Score)

In 1983 Zmijewski used an analysis ratio of liquidity, leverage and measure a company performance. Zmijewski made prediction with a sample of 75 companies bankruptcy, and 73 companies were healthy as long as years of 1972 - 1978, by using Indicators F-Test ratio group of rate of return, liquidity, return on return, fixed payment coverage, trends, firm size, and stock return volatility, show some significant distinction between a healthy and poor company. The model which is developed, as follow:

\[ X = -4.3 - 4.5X1 + 5.7X2 + 0.004X3 \]

Where:
X1 : Earning After Tax to Total Assets  
X2 : Total Debt to Total Assets  
X3 : Current Assets to Current Liabilities

Cut-off which is used in this model, namely 0 (zero), where
• if X has a positive value, it means that the company has a bankruptcy potential, whereas
• if X has more negative value, it means that the company is away from bankruptcy.

Framework

Based on description above, The framework could be described as showed on picture.1 below

![Picture.1 Conceptual Framework](image)

Research Methodology

Sample and Data.

The population in this reseach are all financial report of Garuda Indonesia listed on Indonesian Stock Exchanged. The sample method used is a purposive sampling, so, the numbers of sample was taken in this research was a financial reporting of Garuda Indonesia Airline for period years of 2014 to 2017.

Method of Analysis

The Method of analysis used in this research is a descriptive analysis with a helping of software microssoft exel. The Technic of data analysis used are three models of bankruptcy prediction, namely Altman Z-Score, Springate, dan Zmijewski models

Results and Discussion

The result of all financial aspect assessment of Garuda Indonesia Airline for period years of 2014-2017, showed on tabel 1.

| No | DESCRIPTION | 2014 VALUE | 2014 SCORE | 2015 VALUE | 2015 SCORE | 2016 VALUE | 2016 SCORE | 2017 VALUE | 2017 SCORE |
|----|-------------|------------|-----------|------------|-----------|------------|-----------|------------|-----------|
| 1  | ROE         | -41.15     | 0         | 8.35       | 12        | 0.94       | 2         | -23.85     | 0         |
| 2  | ROI         | 21.51      | 15        | 40.05      | 15        | -1.53      | 1         | -6.15      | 1         |
| 3  | Cash Rasio  | 35.62      | 5         | 43.48      | 5         | 37.01      | 5         | 15.97      | 3         |
Discussion of Financial Performance of Garuda Indonesia Airline, Period Years of 2014 to 2017.

**Return On Equity (ROE)**

As showed on table 1 above, ROE of Garuda Indonesia had a -41.15% value in 2014 and a -23.85% value in 2017 with score value was zero (0) respectively, it proved that company performance was at the worst condition. Moreover company had a 8.35% value in 2015 with score value was 12, and had a 0.94% value in 2016, with score value was 2, it showed that the company performance was fairly well in acquiring profit but the company experienced a profit declining as many 7.41%.

**Return On Investment (ROI).**

As showed on table 1 above, ROI of Garuda Indonesia had a 21.51% value in 2014 and a 40.05% value in 2015 with score value was 15 respectively, it proved that company performance was a very healthy condition. But in 2016 and 2017, Company conversely experienced a declining of ROI drastically with value was -1.53% and -6.15% and have a 1 score respectively. It showed that the ROI of company was in the worst condition.

**Cash Ratio**

As showed on table 1 above, cash rasio of Garuda Indonesia, had an average of 38.70% value since 2014 till 2016 with score 5 respectively, it means that Company had a capability to run its business operation including pay for short-term debt. Meanwhile in 2017, Company conversely experienced a declining of cash rasio up to reach 15.97% with score value 3. It proved that company was initiating to have a financial distress to run its business and pay for short-term debt.

**Current Ratio**

As showed on table 1 above, Garuda Indonesia experienced a fluctuation value of current ratio where company acquired 66.47% in 2014, 84.28% in 2015, 74.52% in 2016, and 51.34% in tahun 2017, cause of current ratio results were smaller than 90%, so the score value were 0 (zero) respectively. It means that the last position of company current asset was smaller than the last of its current liabilities.

**Collection Periods (CP)**

As showed on table 1 above, the collection periods of Garuda Indonesia was tend to decline every years, where CP received for 11.19 days during 2014, 11.63 days during 2015, 18.07 days during 2016 and CP received for 20.03 during 2017, with all score value were 5 respectively. Eventhough, Company had a succesfully to discharge some claims on time, so that the company was still able to run its business.

**Inventory Turnover.**

As showed on table 1 above, the average of inventory turnover of Garuda Indonesia was 9.61 days per year during years of 2014-2017, with score value was 5 respectively. Despite of company inventory turnover seems to be late, but the score was high, it shows that the company operation activities was good to delivery revenue.

**Total Asset Turn Over (TATO)**

As showed on table 1 above, the TATO of Garuda Indonesia had a significat value with the average of tato was 114.5% per year during years of 2014 - 2017, and with average of score value was 4.5. It means that the company had still capabilities to run its business optimally.

**Capital Total to Asset Total (CT to AT)**

As showed on table 1 above, the ratio of capital total to asset total of Garuda Indonesia experienced a fluctuation value, where result of CT to AT rasio was -10.77%, and the score was 0 (zero) in 2014, and 2.15% with score was 4 in 2015, and 1.58% with score value was 4 in 2016, and -4.13% with score was 0 (zero) in
Finding of Bankruptcy Prediction with Altman Z-Score, Springate and Zmijewski Model on Garuda Indonesia, Periode Years of 2014 to 2017.

The Altman Z-Score Model
- Calculation $X_1$ (Working Capital to Total Assets ratio)
- Calculation $X_2$ (Retained Earnings to Total Assets ratio)
- Calculation $X_3$ (Earning before interest and taxes to total assets ratio)
- Calculation $X_4$ (Market Value of Equity to Book Value Of Total Debt ratio)

| Years | Score ($X_1$) | Score ($X_2$) | Score ($X_3$) | Score ($X_4$) |
|-------|---------------|---------------|---------------|---------------|
| 2014  | -0.13         | -0.08         | -0.15         | 0.53          |
| 2015  | -0.06         | -0.06         | -0.03         | 0.25          |
| 2016  | -0.11         | -0.06         | -0.12         | 0.24          |
| 2017  | -0.25         | -0.12         | -0.04         | 0.20          |

**Resources**: Result of Data Processing Year 2019

The Springate Model
- Calculation $X_1$ (Working Capital to Total Assets ratio)
- Calculation $X_2$ (Net Profit Before Interest & Taxes to Total Assets ratio)
- Calculation $X_3$ (Net Profit Before Taxes to Current Liabilities ratio)
- Calculation $X_4$ (Sales to Total Asset ratio)

| Years | Score ($X_1$) | Score ($X_2$) | Score ($X_3$) | Score ($X_4$) |
|-------|---------------|---------------|---------------|---------------|
| 2014  | -0.13         | -0.15         | -0.38         | 1.27          |
| 2015  | -0.06         | -0.03         | -0.09         | 1.15          |
| 2016  | -0.11         | -0         | -0.01         | 1.03          |
| 2017  | -0.25         | -0.04         | -0.08         | 1.11          |

**Resources**: Result of Data Processing Year 2019

The Zmijewski Model
- Calculation $X_1$ (Earning After Tax to Total Assets ratio)
- Calculation $X_2$ (Debt Total to Total Assets ratio)
- Calculation $X_3$ (Current Asset to Current Liabilities ratio)
Result of Rasio Calculation \( X_1, X_2, X_3 \),

| Years | Score \( X_1 \) | Score \( X_2 \) | Score \( X_3 \) |
|-------|-----------------|-----------------|-----------------|
| 2014  | -0.12           | 0.70            | 0.66            |
| 2015  | 0.02            | 0.71            | 0.84            |
| 2016  | 0               | 0.73            | 0.75            |
| 2017  | -0.06           | 0.75            | 0.51            |

**Resources**: Result of Data Processing Year 2019

**Calculation of X-Score Value**

\[
\begin{align*}
\text{X-Score Value} & = -4.3 - 4.5 X_1 + 5.7 X_2 - 0.004 X_3 \\
& = -4.3 - 4.5 (-0.12) + 5.7 (0.70) - 0.004 (0.66) \\
& = 0.22736
\end{align*}
\]

| YEARS | 2014 | 2015 | 2016 | 2017 |
|-------|------|------|------|------|
| \( X_1 \) | \(-4.3 - 4.5 X_1 + 5.7 X_2 - 0.004 X_3 \) | \(-4.3 - 4.5 X_1 + 5.7 X_2 - 0.004 X_3 \) | \(-4.3 - 4.5 X_1 + 5.7 X_2 - 0.004 X_3 \) | \(-4.3 - 4.5 X_1 + 5.7 X_2 - 0.004 X_3 \) |
| \( X_2 \) | \(-4.3 - 4.5 (-0.12) + 5.7 (0.71) - 0.004 (0.84) \) | \(-4.3 - 4.5 (0.02) + 5.7 (0.71) - 0.004 (0.84) \) | \(-4.3 - 4.5 (0.02) + 5.7 (0.71) - 0.004 (0.84) \) | \(-4.3 - 4.5 (-0.06) + 5.7 (0.75) - 0.004 (0.51) \) |
| \( X_3 \) | \(-4.3 - 4.5 (-0.12) + 5.7 (0.71) - 0.004 (0.84) \) | \(-4.3 - 4.5 (0.02) + 5.7 (0.71) - 0.004 (0.84) \) | \(-4.3 - 4.5 (0.02) + 5.7 (0.71) - 0.004 (0.84) \) | \(-4.3 - 4.5 (-0.06) + 5.7 (0.75) - 0.004 (0.51) \) |

**Discussion of Research Result of Bankruptcy Prediction Using Altman Z-Score, Springate and Zmijewski Models Based Engineering Science**

**The Altman Z-Score Model**

Based on research result at Garuda Indonesia and also referred to the Altman Z-Score certainty, concerning with a bankruptcy prediction, as follows: if \( Z > 2.60 \), so the company was in a good condition; if \( 1.1 < Z < 2.60 \), so the company was in a grey area; moreover if \( Z < 1.1 \), so the company was in a bad condition, or was in bankruptcy potential, as showed at table 5.

**Tabel 5** Classification Result of Altman Z-Score Models on Garuda Indonesia

| Years | Score \( X_1 \) | Score \( X_2 \) | Score \( X_3 \) | Score \( X_4 \) | Z-Score | Classification |
|-------|-----------------|-----------------|-----------------|-----------------|---------|---------------|
| 2014  | -0.13           | -0.08           | -0.15           | 0.53            | -1.5651 | Bankruptcy    |
| 2015  | -0.06           | -0.06           | 0.03            | 0.25            | -0.1251 | Bankruptcy    |
| 2016  | -0.11           | -0.06           | 0               | 0.24            | -0.6652 | Bankruptcy    |
| 2017  | -0.25           | -0.12           | -0.04           | 0.20            | -2.09   | Bankruptcy    |

**Resources**: Result of Data Processing Year 2019

Based on data mentioned above could be interpreted, as:

The result of processing by using Altman Z-Score on Garuda Indonesia provided a bankruptcy potential during years of 2014 to 2017. The Z-Score value was in fluctuation and financial position was in distress condition. All these were attributable, as: \( X_1 \) Working capital ratio was negative value cause of current liabilities > current asset, \( X_2 \) Retained Earning ratio was negative value, \( X_3 \) EBIT provided a low value and \( X_4 \) book liabilities value > capital market value.

**The Springate Model**

Based on research at Garuda Indonesia and also referred to Springate certainty, with cut-off, if \( S \)-Score > 0.862, so is classified as a healthy company and if \( S \)-Score < 0.862, so is classified as a bankruptcy company. The result of processing on company during years of 2014 -2017 showed at table 6.

**Tabel 6** Classification Result of Springate Model on Garuda Indonesia

| Years | Score \( X_1 \) | Score \( X_2 \) | Score \( X_3 \) | Score \( X_4 \) | Z-Score | Classification |
|-------|-----------------|-----------------|-----------------|-----------------|---------|---------------|
| 2014  | -0.13           | -0.15           | -0.38           | 1.27            | -0.3372 | Bankruptcy    |
| 2015  | -0.06           | 0.03            | 0.09            | 1.15            | 0.5497  | Bankruptcy    |
| 2016  | -0.11           | 0               | 0.01            | 1.03            | 0.3053  | Bankruptcy    |
| 2017  | -0.25           | -0.04           | -0.08           | 1.11            | 0.0109  | Bankruptcy    |

**Resources**: Result of Data Processing Year 2019

Based on data mentioned above could be interpreted, as:

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The result of processing by using S-Score on Garuda Indonesia provided a bankruptcy potential during years of 2014-2017. The S-Score value was in fluctuation and financial position was in distress condition. All these were result from: (X1) Working capital rasio was negative value cause of current liabilities > current asset, (X2) EBIT provided a low value, (X3) current liabilities was higher than EBIT and (X4) sales experienced a fluctuation during years of 2014-2017.

The Zmijewski Model
Based on research at Garuda Indonesia and refered to the Zmijewski determinate, with cut-off, if X-Score > 0, so is classified as a bankruptcy potential company and if X-Score < 0, so is classified as a healthy company. The result of processing on company during years of 2014-2017 showed at table 7.

| Years | Score (X1) | Score (X2) | Score (X3) | Z-Score | Classification |
|-------|------------|------------|------------|---------|----------------|
| 2014  | -0.12      | 0.70       | 0.66       | 0.22736 | Bankruptcy     |
| 2015  | 0.02       | 0.71       | 0.84       | -0.34636| Healthy        |
| 2016  | 0          | 0.73       | 0.75       | -0.142  | Healthy        |
| 2017  | -0.06      | 0.75       | 0.51       | 0.24296 | Bankruptcy     |

Resources: Result of Data Processing Year 2019

Based on data mentioned above could be interpreted, as:

The result of processing by using X-Score on Garuda Indonesia provided a fluctuation condition during years of 2014-2017, where company experienced a bankruptcy potential in 2014 and 2017, it caused of (X1) Net profit margin ratio was negative value, so the company experienced a disadvantage or loss of profit, moreover company showed a good condition in 2015 and 2016.

Conclusion
Based on result of research executed by using financial analysis ratio and analysis of Altman Z-Score, Springate and Zmijewski models could be concluded, as follow:

Financial performance analysis ratio, Garuda Indonesia had experienced a fluctuation condition since 2014 till 2017, where company financial performance was in unhealthy classification, with score value was 50% in 2014 and 35% in 2016 and 26.46% in 2017, but company financial performance was in good condition in 2015, with score value was 72.14%.

The result analysis of Altman Z-Score and Springate models proved that Garuda Indonesia had experienced a bankruptcy potential since 2014 till 2017. Meanwhile Zmijewski model showed that the company was in a healthy condition in 2015 and 2016. Based on classification level of using three models to make a bankruptcy prediction of the company, Zmijewski model has a more accuracy in bankruptcy prediction of the company than others one. The reason was reinforced by some researchers who had given an evidence of using Zmijewski model, as Fadru and Ridaawi (2020), conducted a research at the company of Pulp and Paper Indonesia, Anu Verma and Jyoti Pandit (2019) executed a research at six selected Public Sector Enterprises of India, M. Fakhri Husein and Galuh Tri Pambekti (2014) performed a research at 19 coal mining companies listed on IDX, and M. Fakhri Husein and Galuh Tri Pambekti (2014), analyzed on 132 companies which are attached on DES (Daftar Efek Syariah).

This research has a limitation, where scope of research focused just on Garuda Indonesia only. Furthermore research, we recommend to compare with others airline, such as: Air Asia, Sriwijaya, Lion Air, Citilink, and Batik Air Airline, etc.

References
1. Darsono. (2010). Financial Management. Jakarta. Nusantara Consulting.
2. Drescher, F. (2014). Insolvency Timming and Managerial Decision-Making. Springer, Munchen.
3. Fahmi, Irham (2016). Theory of Risk Management, Case and Solution. Rev.Ed. Bandung. Alfabet.
4. Harahap, Sofyan Safri.(2013). Analysis Critical on Financial Reporting. Jakarta. Rajawali Pers.
5. Ismail. (2010). Bank Accountancy: Theory and Application, Rev.Edi. Jakarta Prenadamedia Group.
6. Kasmir (2014), Financial Reporting Analysis. Jakarta. Rajawali Pers.
7. Martani, Dwi dkk. (2012), Intermediate Financial Accountancy PSAK-Base, Book I. Jakarta. Salemba Empat.
8. Malyadi. (2016). Cost Accountancy, 5,Ed. Yogyakarta. UPP Higher Learning for Management Science YKPN.
9. Musthafa, (2017), Financial Management. Yogyakarta: Andi Offset
10. Prihadi, Toto. (2010), Financial Reporting Analysis, Theory and Application. Jakarta.PPM
11. Rodoni, Ahmad & Herni Ali. (2014), Modern Financial Management. Jakarta. Mitra WacanaMedia
12. Samryn, L.M. (2012), Basic Accountancy : How to make Journal with Transaction Cycle Approach. Rev.Ed, Book 1, Jakarta. Rajawali Pers.
13. Subrahmanayan, K.R and Wild, John, (2010), Financial Statement Analysis, Mc Graw-Hill Education, USA.
14. Sugiyono. (2010). Quantitative Research Method R & G. Bandung, Alfabeta.
15. Satrisno, (2013), Financial Management: Theory,Concept and Application, 1st Ed., Yogyakarta. Ekonisia.

16. Journals

17. Altman, Edward I. (1968), Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy, Journal of Finance, 389-609, https://doi.org/10.1111/j.1540-6261.1968.tb00843.x
18. Altman, E. I., Iwanicz-Drozdzowska, M., Laitinen, E. K., & Suvas, A. (2017), Financial Distress Prediction in an International Context: a Review and Empirical Analysis of Altman’s Z-Score Model. Journal of International Financial Management & Accounting. Vol. 28(2): 131-171.
19. Anu Verma and Jyoti Pandit (2019), An Analysis of Financial Distress of Selected Public Sector Enterprises of India Using Zmijewski X-Score Model. International Journal of Engineering Development and Research 2019 Vol. 7, Issue 1, ISSN: 2321-9939
20. Fadrul and Ridawati (2020), Analysis of Method Used to Predict Financial Distress Potential in Pulp and Paper Companies of Indonesia. International Journal of Economics Development Research, Volume 1(I), 2020 pp. 57-69
21. Fifrianti, R. and Santosa, P. W. (2018), A Bankruptcy Prediction Analysis with Springate (Model (Case study at Telecomunication Industries, Ltd ), Journal of Economics and Business Aseanomics, 3(1),
22. M. Fakhri Husein and Galuh Tri Pambekti (2014), Precision of the models of Altman, Springate, Zmijewski, and Grover for predicting the financial distress. Journal of Economics, Business, and Accountancy Ventura Vol. 17, No. 3, December 2014, pages 405 – 416
23. M.Noor Salim and Sudiono. (2017), an analysis of bankruptcy likelihood on coal mining listed firms in the indonesian stock exchange: an altman, springate and zmijewski approaches. eurasian journal of economics and finance , 3 (5), 99-108.
24. Ohlson, J.A. (1980), Financial Ratios and the Probabilistic Prediction of Bankruptcy. Journal of Accounting Research, 18(No.1).
25. Onakoya, A.B & A. E. Olotu. (2017), Bankruptcy and Insolvency: An Exploration of Relevant Theories. International Journal of Economics and Financial Issues, 2017, 7(3): 706-712.
26. Peter dan Yosep. (2011), Bankruptcy Analysis with Z-Score Altman, Springate and Zmijewski Methods (Case study at Indofood Sukses Makmur,Ltd)
27. Santosa, P. W. (2010) Longterm Trends Analysis of Managing Expectation for Active Value. Jurnal Akuntansi dan Keuangan. 12(2), 94-115,
28. Sari, E.W. (2014), Application of Zmijeski, Springate, Altman Z-Score, and Grover models in Bankruptcy Prediction on Public Transportation Listed on Indonesian Stock.
29. Setiadi, A. (2011), Financial Distress Analysis on bankruptcy prediction with Altman’s Z-Score model (Case study at Bakrie & Brothers,Ltd )
30. Springate, Gordon L.V. (1978), Predicting the Possibility of Failure in a Canadian Firm. M.B.A. Research Project, Simon Fraser University.
31. Venkataramanan, et.a (2012), Financial Performance and Predicting the Risk of Bankruptcy: A Case of Selected Cement Companies in India. International Journal of Public Administration and Management Research 1 : 40–56.
32. Zmijewski, Mark. (1983), Predicting Corporate Bankruptcy: An Empirical Comparison of the Extant Financial Distress Models. Working paper. SUNY at Buffalo.
33. www.idx.com