



# Determining Optimization of the Finance Distress Parameters of Islamic Bank by Using Grey Relational Analysis (GRA)

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**Abstract.** This study aims to identify potential causes of financial distress by combining Grey Relation Analysis (GRA) with internal and external variables of Islamic banking companies in Indonesia. The data utilized is panel data for the period 2015–2019, with an Indonesian sample of five established Islamic banking institutions. The findings of this study indicate that, in general, the factors that allow financial distress to occur in Islamic Commercial Banks are distinct. However, banks must keep an eye out for a few unique factors that may be the primary cause of financial distress in banking institutions. This research also contributes to cautioning Islamic banking institutions regarding the internal management of Islamic banking's sustainability and the anticipation of future financial distress.

**Keywords:** Financial Distress · Islamic Commercial Bank · Grey Relation Analysis (GRA) · Panel Data

## 1 Introduction

Financial distress is the stage of a company's financial decline preceding its bankruptcy or liquidation [1]. The legal term bankruptcy refers to the cessation of a company's business operations within a specific legal framework [2]. Moreover, according to Beaver, Correia, and McNichols [3], financial distress can also be defined as a company's inability to meet

its financial obligations. This condition is very likely to affect businesses in all industries, including Islamic banking in this instance.

Islamic banks are banks with unique characteristics that operate in accordance with Islamic sharia principles, i.e., they adhere to the provisions of Islamic teachings regarding transaction procedures [4]. In terms of determining the prices of their products, Islamic banks differ significantly from conventional banks. The determination of prices for Islamic banks is based on an agreement between the bank and the customer as a depositor of funds, with the type of deposit and the length of time determining the size of the depositor's share of the profit sharing. Islamic banks employ a profit-sharing and revenue-sharing model rather than a system of interest to conduct their business [5].

Indicators of financial distress are quite prevalent in Islamic banking, but managers are still able to mitigate it with oversight from the regulator, thereby preventing a more severe impact [6]. This phenomenon has prompted a significant number of researchers to examine the factors that influence financial distress in Indonesian banking. It is interesting to compare because the banks chosen as research objects, the variables involved, and the analytical tools employed are quite diverse.

Since Beaver's groundbreaking work on financial distress in 1966, numerous studies have utilized financial ratios to forecast financial failure. Altman was the first researcher to use discriminant analysis to predict bankruptcy by combining financial ratios into a single bankruptcy predictor [7]. This method's ability to reduce multidimensional problems to a single score is its primary advantage (z-score). Although discriminant analysis is widely applied to the problem of predicting financial difficulties, it is susceptible to the following issues: (1) The used financial data must be processed in a linear fashion, and (2) the data must be comprehensive. In statistics, the correct analysis is one that uses the data as they are. Using a combination of Grey Relation Analysis, we will therefore attempt in this study to employ an alternative method for analyzing financial distress.

According to the search results, logistic regression, multiple regression, and panel data regression are the most used analyses in Indonesian financial distress research. Several studies, including [8–10], employ logistic regression. While multiple regression was used as an analytical tool in Africa [11] and Aminah, Rizal, and Taufiq's [12]. As an analytical tool, the Yudowati [13], and Nelmida [14] utilized panel data regression. However, no instances of analytical tools employing Grey Relation Analysis (GRA) have been discovered. This study will attempt to identify the determinants of financial distress using a combination of Grey Relation Analysis (GRA) and the z-score equation with 11 internal and external variables for companies in Indonesia such as Islamic banking.

## 2 Related Work

Various studies have examined allegations of financial distress within a company. One of the pioneers is Altman (1968), whose research demonstrates that accounting variables can be used to predict the likelihood of financial distress among companies [15]. After that, many researchers were interested in analyzing the state of financial distress in a variety of companies using different methodologies. Additionally, researchers strive to formulate the most accurate definition of financial distress. According to Aouaki and Heijer [16], a company will experience financial distress when it is unable to meet

its financial obligations (especially to lenders) (financial distress). If a company owes numerous parties who influence its capital structure, the situation becomes more complicated. Funding the company's needs with debt can result in an increasing conflict of interest between shareholders and creditors. In addition, the two researchers noted that there are direct and indirect costs associated with financial distress. According to Plat and Plat [1], financial distress is the stage of a company's financial decline that occurred prior to its bankruptcy or liquidation. The legal term bankruptcy refers to the cessation of a company's business operations within a specific legal framework [17]. According to Beaver et al. [3], financial distress can also be defined as a company's inability to pay its maturing financial obligations [18]. This condition is very likely to affect businesses in all industries, particularly if the country in which they operate is experiencing a recession. According to numerous researchers, closely monitoring and analyzing a company's financial statements is one of the most effective methods for preventing financial distress.

Previous studies used more analytical tools in the form of simple regression and statistical analysis tools and mostly only used internal variables. Therefore, this study will try to use proxies for external variables such as Gross Domestic Product (GDP) and Inflation Rate (INF). While the internal variables are Total Equity loans (EQL), Impaired Loans Gross Loans (IMGL), Returns of Assets (ROA), Returns of Equity (ROE), Capital of Assets (CTA), Loan Loss Reserves of Gross Loans (LLRGL), Loan Loss Provisions of Net Interest income (LLPNII), Net Loans of Total Assets (NLTA), Net Loans of Deposits and short-term financing rate (NLDSF).

### 3 Methods

A component of the Grey System Theory, grey relational analysis examines the degree of grey relations between each factor in the Grey System. According to its definition, grey systems are a multidisciplinary technique used for abstract modeling and analysis of systems with little, inaccurate, or unreliable information.

The GRA technique, also known as the whitening of factor relations, deals to the computation of the impacts of numerous factors and their relationships. The GRA technique compares each item quantitatively based on the degree of similarity and variance between factors to uncover links between them. It employs data from the grey system.

The output replies' experimental data are first standardized between the ranges of 0 and 1 before being used in the grey relational analysis. Grey relational generation is the term for this procedure. Once the experimental data have been normalized, the relationship between the actual and desired data is expressed using grey relational coefficients. Then, by averaging the output replies' grey relational coefficients, the overall grey relational grade is determined. The resulting grey relational grade determines how well the multi-objective procedure performs overall.

### 3.1 Setting up the Value of the Matrix

Data processing is carried out to convert complex and uncertain data into data in the form of a matrix  $i \times k$  the number of samples taken is denoted by  $i$  and the number of observations for each sampling is denoted by  $k$ .

$$X = \begin{bmatrix} x_1(1) & x_1(1) & \dots & x_1(1) \\ x_1(1) & x_1(1) & \dots & x_1(1) \\ \vdots & \vdots & \vdots & \vdots \\ x_1(1) & x_1(1) & \dots & x_1(1) \end{bmatrix} \tag{1}$$

### 3.2 Standardized Data Transformation

In general, there are three categories into which influence elements in the grey system can be divided:

- **Benefit-type factor:**  
Factors that have a greater value than the original data show better quality characteristics (larger-the-better).

$$x_i^*(k) = \frac{x_i^{(0)}(k) - \min x_i^{(0)}(k)}{\max x_i^{(0)}(k) - \min x_i^{(0)}(k)} \tag{2}$$

- **Defect-type factor:**  
Factors that have a value that is smaller than the original data show better quality characteristics (the smaller-the-better).

$$x_i^*(k) = \frac{\max x_i^{(0)}(k) - x_i^{(0)}(k)}{\max x_i^{(0)}(k) - \min x_i^{(0)}(k)} \tag{3}$$

- **Medium-type or nominal-the best:**  
Factors that have the same value or closest to the specified value standard show better quality characteristics.

$$x_i^*(k) = 1 - \frac{|x_i^{(0)}(k) - x_{iv}^{(0)}|}{\max\left(\left(\max x_i^{(0)}(k) - x_{iv}^{(0)}\right), \left(x_{iv}^{(0)} - \min x_i^{(0)}(k)\right)\right)} \tag{4}$$

where:

- $x_i^*(k)$  is Data following grey-relational generation.
- $\max x_i^{(0)}(k)$  is maximum value of the original sequence factor.
- $\min x_i^{(0)}(k)$  is minimum value of the original sequence factor.
- $x_{iv}^{(0)}$  default value (target value).

Data standardization is a stage in Grey relational generation where experimental results are normalized to values on a scale of 0 to 1 due to different units of measurement. Data preprocessing converts the original sequences into a set of comparable sequences [19].

### 3.3 Determining Deviation Sequence

The deviation sequence calculation aims to determine the absolute difference between the compared series and the referential series using the following formula.

$$\Delta_{0i}(k) = |x_0^*(k) - x_i^*(k)| \tag{5}$$

where:

- $\Delta_{0i}(k)$  deviation sequence.
- $x_0^*(k)$  reference sequence.
- $x_i^*(k)$  comparability sequence.

### 3.4 Determination of Grey Relational Coefficient and Grey Relational Grade

The calculation of the Gray Relational Coefficient (GRC) is carried out to determine the sequence with the lowest deviation using a discriminating coefficient between 0 and 1. In general, the discriminating coefficient is 0.5. The sequence with the lowest deviation will produce the GRC with the highest value, which is 1.

$$\xi_i(k) = \frac{\Delta_{\min} + \rho \Delta_{\max}}{\Delta_{oi}(k) + \rho \Delta_{\max}} \tag{6}$$

where:

- $\xi_i(k)$  is grey relational coefficient.
- $\rho$  is distinguishing coefficient (0.5).
- $\Delta_{\min}$  is the lowest deviation sequence.
- $\Delta_{\max}$  is the deviation sequence.

### 3.5 Determination of Grey Relational Grade

Grey relational grade (GRG) represents the level of correlation between reference and comparability sequences. The greater the Grey relational grade, the stronger the correlation between the reference and comparability sequences. The GRG calculation is done using the following formula.

$$r_i = \sum_{k=1}^n (w(k) \times \xi_i(k)) \tag{7}$$

where:

- $r_i$  Grey relational grade.
- $w(k)$  Proportion of the number k influence factor.

**Table 1.** Research variable and Indicator.

Variable	Indicator	Ratio	Variable definition
Risk	Insolvency Risk	Z-Score	$\frac{(\text{Return on assets capital Ratio})}{\text{return on assets standard deviation}}$
	Credit Risk	EQL	Total Equity/Net loans
		IMLGL	Impaired Loans/Gross Loans
Profitability		ROA	Net returns/Total assets
		ROE	Net returns/Equity
Microeconomics (Internal Indicator)	Capital	CTA	Capital/Total assets
	Asset quality	LLRGL	Loan Loss reserves/Gross Loans
		LLPNII	Loan Loss Provisions/Net Interest income
	liquidity	NLTA	Net Loans/Total assets
		NLDSF	Net Loans/Deposits and short-term financing rate
Macro Economics (External Indicator)	Real GDP	GDP	GDP growth rate (%)
	Inflation rate	INF	Inflation rate (%)

The basis for the total response of the several performance metrics is the grey relational grade, which serves as our objective function. Instead of challenging multiple-objective characteristics, one grey relational grade can be optimized this way. The closer a parameter combination is to the ideal set of input parameters, the higher the grey relational grade. The ideal parameter setting (according to the HB criterion) is the one with the highest S/N ratio. An ideal combination can be created by graphically representing the S/N ratio for the total grey relational grade.

### 3.6 Research Variable

See Table 1.

## 4 Result and Discussion

This study identifies the factors causing financial distress in Islamic commercial bank companies registered with the Financial Services Authority (OJK) between 2015 and 2019. Currently, there are 15 Islamic commercial banks registered with the OJK, but the researchers only randomly selected 5 Islamic commercial banks. Sampled, namely: Bank Aceh Syariah, Bank Muamalat, BPD NTB Syariah, Bank Mandiri Syariah, and Bank BRI Syariah. The Last Bank is a state-owned bank that has merged to become Bank Syariah Indonesia (BSI).

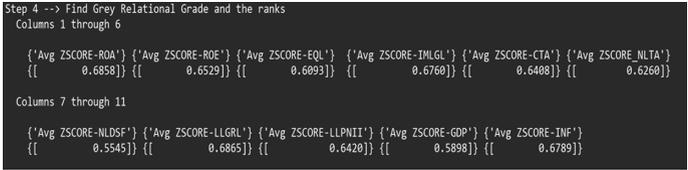


Fig. 1. Grey Relational Grade and Ranks of Bank Aceh Syariah.

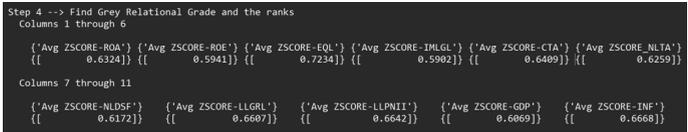


Fig. 2. Grey Relational Grade and Ranks of Bank Muamalat.

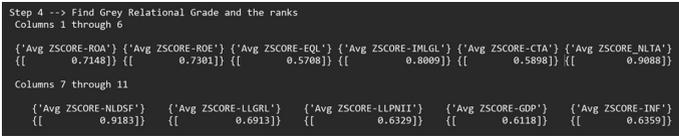
### 4.1 Bank Aceh Syariah

Step 4 reveals, based on the results of the z-score calculation with the GRA combination, that the variable with the highest z-score value is LLGRL (0.6865). This suggests that macroeconomic variables, specifically asset quality, or, more precisely, loan loss reserves of gross loans, are the most significant determinant of the likelihood of financial distress. Bank Aceh Syariah must certainly anticipate this for the future. Meanwhile, the variable NLDSF has the smallest coefficient value (0.5545). This variable is also a macroeconomics variable (external variable) that serves as an indicator of banking liquidity by dividing Net Loans by Deposits and the short-term financing rate (Fig. 1).

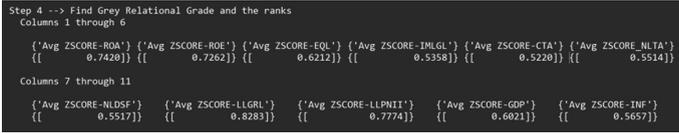
### 4.2 Bank Muamalat

The credit risk variable, EQL (0.7234) total equity of net loans, reveals the dominant factor that can cause PT. Bank Muamalat to experience financial distress in the future, as seen in Fig. 2. Total Net Equity is defined as total assets minus total liabilities, excluding all third-party payables, intercompany accounts, and minority interest, calculated on a consolidated basis for the Company and its Subsidiaries. In the meantime, the IMGL credit risk variable (0.5902), Impaired loans of gross loans, was the most important factor in this bank’s ability to weather the financial storm. Impaired loans are loans for which the contractual principal and margin are unlikely to be repaid.

Consistent with the findings of [20, 21], this study determined that PT. Bank Muamalat Indonesia Tbk has a z-score value of less than 1.1, indicating that it is in an unhealthy condition or is in the Distress Zone area, with the meaning of the word that PT. Bank Muamalat Indonesia Tbk. is in an unhealthy condition and has the potential for financial difficulties in the Due to low Equity loan (EQL) conditions, PT. Bank Muamalat Indonesia Tbk’s operating profit (EBIT) decreased from 2016 to 2018 as shown in the company’s Income Statement.



**Fig. 3.** Grey Relational Grade and Rank of Bank BPD NTB Syariah.



**Fig. 4.** Grey Relation Grade Result Bank Syariah Mandiri.

**4.3 BPD NTB Syariah**

The Regional Development Bank of West Nusa Tenggara Syariah (BPD NTB Syariah) is a bank in which the provincial government of West Nusa Tenggara holds most shares. Figure 2 reveals that the EQL variable has the lowest z-score value (0.5708). Thus, the most stable variable among the company’s internal variables is this bank’s credit risk. Moreover, the NDLS coefficient (0.9183) is a determining factor that this bank must keep an eye on because it has the potential to be the primary cause of financial distress (Fig. 3).

**4.4 Bank Syariah Mandiri and Bank BRI Syariah (Now BSI)**

Bank Mandiri Syariah and Bank Rakyat Indonesia Syariah (BRI Syariah) are state-owned banks which have now been merged into Bank Syariah Indonesia in 2019. This study’s data is limited to 2019, so if these two banks have not merged into Islamic banks in Indonesia by then, the conclusion cannot be drawn (BSI). LLGRL (Loan Loss reserves/Gross Loans) has the highest Z-Score value (0.8283) among the 11 variables analyzed, as determined by the results of combining the Gray Relation variable. This indicates that this variable is the most important variable as the primary cause if this bank experiences financial distress. Capital of assets in the bank is the most stable variable as a support, as CTA (0.522) is the variable with the lowest value in the graph (Figs. 4 and 5).

In contrast to Bank Mandiri Syariah (as shown in Fig. 6), the variable LLGRL has the lowest z-score at Bank BRI Syariah (0.5777). This indicates that the BRI Syariah bank has the most robust variable as an operational support in order to avoid financial distress, namely the internal variable that is a component of asset quality. The credit ratio, EQL, is the variable that must be considered because it can be the primary cause of financial distress at this bank (0.708). In the meantime, for other variables, it appears typical of a bank in general.

Figure 6 of this study clearly identifies the factors that cause financial distress in Islamic banking. The 11 variables identified through research are depicted in a circle.

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Step 4 --> Find Grey Relational Grade and the ranks
Columns 1 through 6
{'Avg ZSCORE-ROA'} {'Avg ZSCORE-ROE'} {'Avg ZSCORE-EQL'} {'Avg ZSCORE-IMLGL'} {'Avg ZSCORE-CTA'} {'Avg ZSCORE-NLTA'}
[[ 0.6541]] [[ 0.6529]] [[ 0.7088]] [[ 0.7240]] [[ 0.6947]] [[ 0.7812]]

Columns 7 through 11
{'Avg ZSCORE-NLDSF*'} {'Avg ZSCORE-LLGRL'} {'Avg ZSCORE-LLPNI1'} {'Avg ZSCORE-GDP'} {'Avg ZSCORE-INF'}
[[ 0.6255]] [[ 0.5777]] [[ 0.6427]] [[ 0.6941]] [[ 0.6052]]
    
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Fig. 5. Grey Relation Grade Result Bank Rakyat Indonesia Syariah.

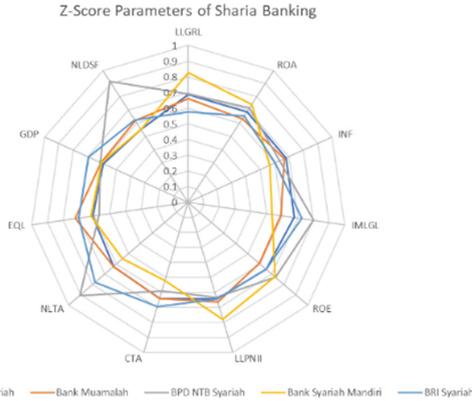


Fig. 6. Z-Score Parameter Finance Distress of Sharia Banking.

Where the variable whose value is increasing will leave the center circle. While the variable with a low value (z-score coefficient) approaches the center of the circle. Consequently, the primary determinant of financial distress is a variable that is moving away from the circle’s center. It is evident that the NLDSF and NLTA values are the greatest.

### 5 Conclusion

Using Grey Relation Analysis (GRA), this study was conducted to identify factors that have the potential to cause financial distress. Adding external variables (macroeconomics) influenced the results of the identification of factors that influence the occurrence of financial distress when using different variables. EQL was identified as a determinant of financial distress at Bank Muamalat and BRI Syariah out of the five sampled Islamic banks. LLGRL was determined to be a factor in financial distress at Bank Aceh Syariah and Bank Syariah Mandiri. BPD NTB Syariah is distinguished from other banks by a few factors. It is precisely the NLDSF variable that determines whether a bank is in financial distress. The findings of this study indicate that, in general, the factors that allow financial distress to occur in Islamic Commercial Banks are distinct. However, Islamic banking must also keep an eye out for several unique variables that may be the primary cause of financial distress in banking institutions. This research also contributes to providing input on the prudence of Islamic banking companies in managing their internal management in order to avoid future financial distress.

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