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FINANCIAL DISTRESS PREDICTION ON FINANCIAL SECTOR SERVICE COMPANIES ON INDONESIAN STOCK EXCHANGE USING COX PROPORTIONAL HAZARD

Candra Yanuar Dwi Putra[1], Mohamat Fatekurohman[2*], Dian Anggraeni[3]

[1,2,3]Mathematics Department, Faculty of Mathematics and Natural Sciences, Universitas Jember
Kalimantan St., No. 37, Kampus Bumi Tegalboto, Jember 68121, Indonesia

Corresponding author's e-mail: [2*] *mfatekurohman.fmipa@unej.ac.id*

Abstract. *A company that cannot compete with its competitors can experience financial difficulties, commonly referred to as financial distress. Financial distress is a stage of a decline in the company's financial condition or a situation of financial difficulty that occurred before the company went bankrupt. This study aimed to determine the factors that predict a company experiencing financial distress. The factors suspected in this study include leverage, profitability, firm size, free cash flow, and sales growth. The method used was the Cox Proportional Hazard model. The research data was on financial sector service companies listed on the Indonesia Stock Exchange (IDX) for five years of observation, from 2016 to 2020. Based on the results of the analysis of financial distress predictions using the Cox Proportional Hazard model, it is found that the factors that have a significant effect on predicting companies experiencing financial distress are profitability and firm size.*

Keywords:*financial distress,survival analysis, cox proportional hazard*

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1. INTRODUCTION

Every company must be able to maintain and stabilize the viability of the company so that the company's goals can be adequately achieved. The entry of competitors gives companies the motivation to formulate strategies to move forward and maintain company stability. When a company cannot compete with its competitors, it is likely to experience financial difficulties, commonly called financial distress. Financial distress is when the company experiences financial difficulties before the liquidation or bankruptcy process [1]. The occurrence of financial distress is before liquidation or bankruptcy, where liquidation or bankruptcy is generally defined as a situation or condition where the company can no longer fulfill its obligations due to a lack of costs in continuing the business so that no profit can be achieved [2]. Financial distress begins with the inability to fulfill the company's obligations, especially regarding its short-term obligations, including liquidity and obligations in the solvency category. [3].

Financial distress can indicate an unhealthy company's financial condition and is the leading cause of the company's bankruptcy. Three circumstances cause financial distress, which can be seen from the financial condition, including too significant a debt burden, a lack of capital, and a continuous loss. Circumstances that can cause financial distress are seen in their financial condition, such as having large debts and experiencing continuous losses. The balance of these conditions needs to be maintained so that a company can avoid a condition called financial distress until bankruptcy occurs. Sustained financial distress conditions will result in bankruptcy, which harms all company members, especially the company's stakeholders [4]. The financial distress condition of a company can be known in several ways, one of which is by looking at the company's earnings per share (EPS). If the company has a negative EPS, it can be said that a company is in distress. On the other hand, if the company has a negative EPS, it can be said that it is not experiencing distress [5].

Survival analysis is one of the tools that can be used to measure the possibility of financial distress. The survival analysis method explicitly discusses the way a company develops over time. The advantage of survival analysis compared to other statistical analysis options is the existence of a censorship concept which, according to [6], censored data is data that cannot be observed thoroughly because there are individuals who have come out of observation but have not experienced the event or the individual's observation has not experienced a specific event in the end. One of the semiparametric models, namely Cox regression, was used to depict a survival curve when considering risk factors simultaneously. The basic model for survival data is the proportional hazard model. The general model of Cox Proportional Hazard, according to [7], is stated in the following equation:

$$\begin{aligned} h(t) &= h_0(t)\exp(\beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_n x_n) \\ &= h_0(t)\exp(\textstyle\sum_{i=1}^{n}\beta_i X_i) \end{aligned} \quad (1)$$

The Cox Proportional Hazard model is applied to survival data where the data used for this model must meet the proportional hazard assumption [8].

Previous research [9] used the Cox Non-proportional Hazard model to analyze the relationship between *financial distress* and dividend omission policy decisions in manufacturing companies. Research [10] uses Cox Proportional Hazard Regression to analyze the factors that affect the time a company experiences *financial distress*. Finally, research [11] uses Cox Proportional Hazard Regression to analyze the company's *financial distress*.

In this study, the survival analysis used was Cox Proportional Hazard Regression. The data was the data of financial sector service companies listed on the Indonesia Stock Exchange. Observations were made over five years, from 2016 to 2020. This study was conducted to determine the factors that predict a company experiencing *financial distress*. Factors that are thought to affect the duration of time the company experiences *financial distress* in this study include leverage, firm size, profitability, free cash flow, and sales growth.

2. RESEARCH METHOD

2.1 Research data

In this study, the type of data used was secondary data which included financial reports on financial sector service companies listed on the Indonesia Stock Exchange. The data source to be used as secondary data is obtained by downloading data through the websites www.sahamok.net and www.idx.co.id. After using purposive sampling, 70 companies that meet the criteria were obtained. Company data status was indicated by censored data (0 = not experiencing *financial distress*) and uncensored data (1 = experiencing *financial distress*).

The following is the survival time in this study. It shows the observation of events from the beginning of the observation to the end of the observation time:

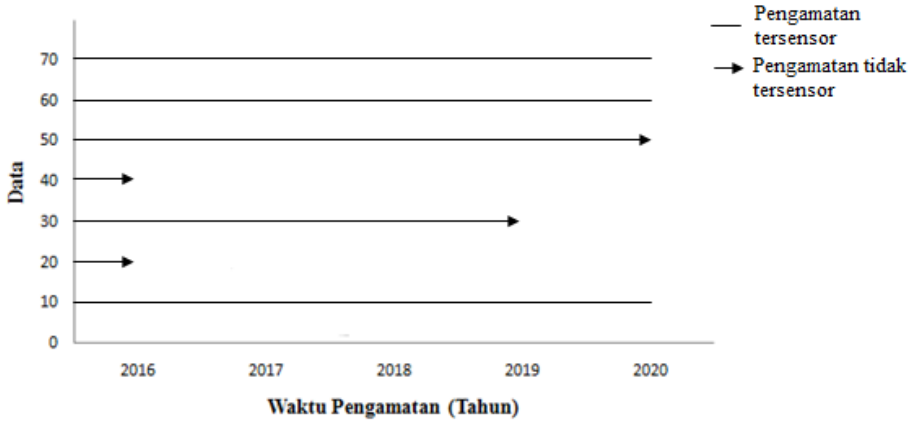


Figure 1. *Survival Time*

The variables used in this study are:

a. The response variable (Y) is the length of time the company's survival experiences *financial distress* until bankruptcy occurs
b. The independent variables (X) include:
   1. *Leverage* (X_1)
      Leverage ratio is a measurement of how much a company is financed with debt [12].
      $$Debt\ to\ Asset\ Ratio = \frac{Total\ liability}{Total\ assets} \quad (2)$$
   2. Profitability (X_2)
      The income ratio is a ratio in assessing the ability of a company to seek profit [13]. The income ratio can be searched using ROA (Return on Assets).
      $$ROA = \frac{Net\ profit}{Total\ assets} \quad (3)$$
   3. Firm size (X_3)
      Firm size is a measure that can categorize large and small companies through various ways including total asset sales, stock market value and average level of sales. [14].
      $$Size = \ln(Total\ Aset) \quad (4)$$
   4. *Free Cash Flow* (X_4)
      Free Cash Flow can be expressed as the ratio of free cash flow divided by total assets. According to [13], free cash flow can be calculated by the formula:
      $$FCF = \frac{Operating\ cash\ flow - capital\ expenditure}{Total\ assets} \quad (5)$$
   5. *Sales Growth* (X_5)
      Sales growth is a measurement of a company's ability to maintain its economic position in the midst of its economic growth [15].
      $$Sales\ Growth = \frac{Sale(t) - Sale(t-1)}{Sale(t-1)} \quad (6)$$

2.2 Research Steps

The method used was Cox Proportional Hazard regression using R software. The research steps carried out include:

a. Data collection.
b. Determination of the variables.
c. Descriptive analysis of each independent variable.
d. Draw the survival function curve of each variable with Kaplan-Meier.
   Testing the difference in the survival function curve of each variable using the Log-rank Test.
e. Testing the assumptions of proportional hazard modeling on each independent variable by Goodness of Fit.
f. Cox Proportional Hazard parameter estimation modeling.
g. Cox stratified modeling.
h. The significance test of the best model
i. Selection of the best model using the smallest AIC and backward elimination.
j. The best model interpretation with Hazard Ratio.
k. Conclusion

3. RESULT AND DISCUSSION

3.1 Descriptive Analysis

The data used included 70 financial sector service companies on the Indonesia Stock Exchange (IDX). The resulting event data was divided into censored and uncensored (observed) data. The percentage of censored event data was 61%, or 43 companies. The percentage of uncensored event data (observed) was 39%, or 27 companies.

Table 1. Descriptive Analysis of each Independent Variable

Independent Variable	*n*	*min*	*max*	*median*	*mean*
Leverage	70	0,01311	2,14223	0,7751	0,68746
Profitability	70	-0,2632404	0,1016988	0,017692	0,0061924
Firm size	70	24,7	34,77	29,16	29,64
Free Cash Flow	70	-0,354994	0,19283	-0,006701	-0,03279
Sales Growth	70	-0,58593	5,10827	0,05561	0,13664

Table 1 shows the min (minimum), max (maximum), median (middle value), and mean (average) values of each independent variable. The average leverage value from 70 data on financial sector service companies is 0.68746, which means the company finances the company operations with a debt of 68.74% of the company's total assets. It indicates that the average company is still quite prominent in having company obligations. The average value of profitability from 70 data on financial sector service companies is 0.006194, meaning the company has a net profit of 1% of the total assets. It indicates that the average company earns a net profit.

The average value of firm size from 70 data on financial sector service companies is 29.64, which means that the size of the company from the total assets owned is quite large. It indicates that the average company is classified as a medium-sized company. The average value of free cash flow from 70 data on financial service companies is -0.03279. The company's cash inflows are smaller than cash outflows, so free cash flows are negative. It indicates that the average company has a negative free cash flow. The average value of sales growth from 70 data on financial sector service companies is 0.13664, which means the company's revenue growth is 13% from the previous year. It indicates that the average company is experiencing revenue growth.

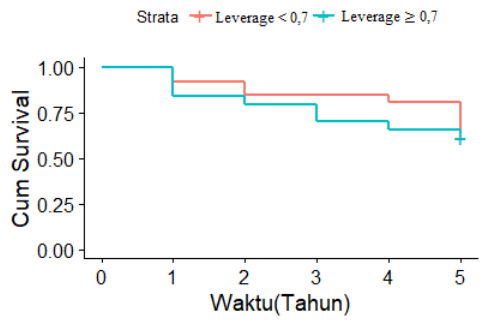
The results of the descriptive analysis of each variable in Table 2 are then used to categorize each variable. Analysis of the characteristics of the independent variables is shown in Table 2, below.

Table 2. Analysis of the Characteristics of each Independent Variable

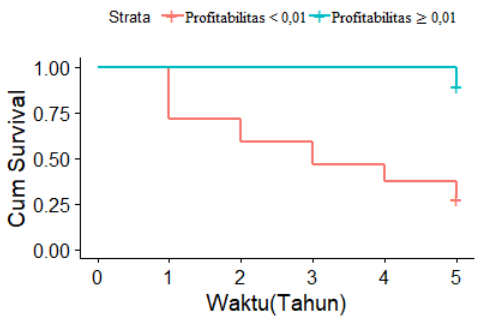
Variable	Category	Number of Companies	Percentage
Leverage	*Leverage* < 0,7	25	36%
	Leverage ≥ 0,7	45	64%
Profitability	Profitability < 0,01	32	46%
	Profitability ≥ 0,01	38	54%
Firm Size (*size*)	24,5 ≤ *size* <28	14	20%
	28 ≤ *size*< 31,5	41	59%
	31,5 ≤ *size*< 35	15	21%
Free Cash Flow (FCF)	FCF is negative	40	57%
	FCF is positive	30	43%
Sales Growth (SG)	SG is negative	22	31%
	SG is positive	48	69%

3.2 Kaplan-Meier Method Analysis and Log-Rank Test

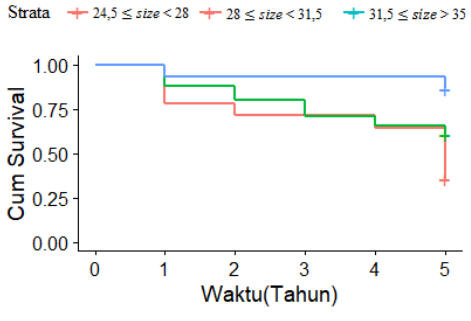
Kaplan-Meier curve was used to determine the characteristics of the survival time of financial sector service companies. The resulting curve for each independent variable is



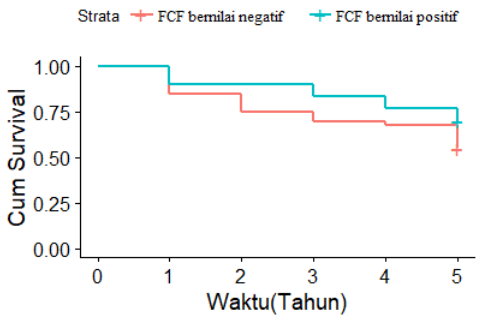
(a) *Leverage* Variable



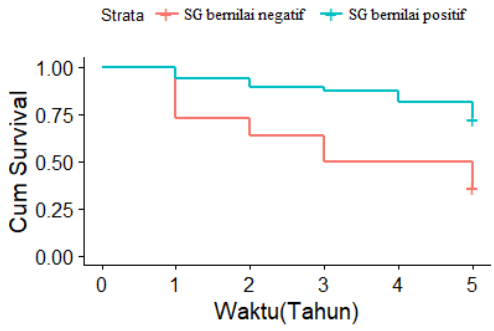
(b) Profitability Variable



(c) Firm Size Variable



(d) *Free Cash Flow* Variable



(e) *Sales Growth* Variable

Figure 2. Kaplan Meier curve of independent variables

It is shown in figure 2 that the curve under the other curve indicates that the company has a lower survival time in experiencing *financial distress,* Conversely, the curve above the other curve means that the company has a higher survival time in experiencing *financial distress*.

Log-Rank test was conducted to determine the difference in survival time of each independent variable of financial sector service companies. Log-rank test was done by rejecting H_0 if the *p*-value < α =0.05. The tests used in the Log-rank test were as follows:

H_0: There was no difference in the survival curves between the different groups

H_1: There are differences in the survival curves between different groups

Log-rank test analysis on financial sector service companies can be seen in the following table.

Table 3. Log-Rank test of independent variables

Variable	*Log-rank*		Interpretation
	p-value	**Sig**	
Leverage	0,8	0,05	H_0 Accepted
Profitabilitas	0,6e-08		H_0 Rejected
Ukuran Perusahaan	0,03		H_0 Rejected
Free Cash Flow	0,2		H_0 Accepted
Sales Growth	0,001		H_0 Rejected

Table 3 shows the log-rank test for each independent variable. Variables with a *p*-value < α = 0.05 include profitability, firm size, and sales growth. Therefore, the decision H_0 hypothesis is rejected, which means that there are differences in the survival curve for the variables of profitability, firm size, and sales growth. Variables with *p*-value > α = 0.05 include leverage and free cash flow variables, so H_0 is accepted. It means that there is no difference in the survival curve for leverage and free cash flow variables.

3.3 Assumption of Proportional Hazard

The proportional hazard assumption test was conducted to test the correlation between variables using Goodness of Fit, namely Schoenfeld Residuals. The test was carried out by rejecting H_0 if the *p*-value < α = 0.05. The test used in the proportional hazard assumption test was:

H_0 = proportional hazard assumption is met.

H_1 = proportional hazard assumption is not met.

The results of the proportional hazard assumption test can be seen in the following table

Table 4. Proportional Hazard Assumption Test

Variable	**Asumsi PH**		Decision
	p-value	**Sig**	
Leverage	0,050	0,05	H_0 Accepted
Profitability	0,067		H_0 Accepted
Firm size	0,209		H_0 Accepted
Free Cash Flow	0,878		H_0 Accepted
Sales Growth	0,779		H_0 Accepted

Table 4 shows that the *p*-value for all independent variables is greater than the significance value α = 0.05, so H_0 is accepted. It can be interpreted that all independent variables meet the proportional hazard assumption.

3.4 Cox Proportional Hazard Parameter Estimation

The independent variables that have met the assumptions will then be estimated for the Cox Proportional Hazard model parameters. The results of the parameter estimate for the independent variables are shown in Table 5 below.

Table 5. Cox Proportional Hazard Model Parameter Estimation

Variable	Coef	*p-value*
Leverage ($\mathbf{X_1}$)	-0,1090	0,8644
Profitabilitas ($\mathbf{X_2}$)	-2,5307	0,511e-04
Ukuran Perusahaan ($\mathbf{X_3}$)	-0,8268	0,0918
Free Cash Flow ($\mathbf{X_4}$)	-0,7686	0,0851
Sales Growth ($\mathbf{X_5}$)	-0,9269	0,0311
Likelihood ratio		0,4e-07

Table 5, shows the parameter estimation results so that the Cox Proportional Hazard Regression equation is obtained as follows:

$$h(t) = h_0(t)\exp\left(-0{,}1090\mathrm{X}_1 - 2{,}5307\mathrm{X}_2 - 0{,}8268\mathrm{X}_3 - 0{,}7686\mathrm{X}_4 - 0{,}9269\mathrm{X}_5\right) \quad (7)$$

Parameter testing was done to determine which parameters significantly affected the Cox Proportional Hazard model. Parameter testing was done by simultaneous test and partial test or Wald. Simultaneous testing is carried out by testing the parameters simultaneously by looking at the *p*-value Likelihood ratio in Table 5, which is 0.04e-07 which is smaller than the significance value $\alpha = 0.05$, so H_0 is rejected. It means that at least there are independent variables that have a significant effect on the model.

Partial tests were carried out one by one on the model parameters by looking at the *p*-value of each variable. The partial test results show that the variables that do not have a significant effect are leverage, firm size, and free cash flow because the *p*-value > α, so H_0 is accepted. The conclusion is that there are still insignificant parameters to the model, so backward elimination will be carried out based on the criteria for the smallest AIC value. Backward elimination with the minor AIC value criteria can be seen in table 6 below

Table 6. Backward elimination with the smallest AIC value

Stage-	Variable	AIC
1	*Leverage*, Profitability, Firm size, *Free Cash Flow*, *Sales Growth*	187,19
2	Profitability, Firm size, *Free Cash Flow*, *Sales Growth*	185,22

The parameter estimation results after backward elimination can be seen in the following table.

Table 7. Estimation of Model Parameters

Variable	Coef	*p-value*
Profitability (X_2)	-2,48546	0,113e-04
Firm size (X_3)	-0,88467	0,0129
Free Cash Flow (X_4)	-0,77368	0,082
Sales Growth (X_5)	-0,94917	0,0205
Likelihood ratio		0,1e-07

Table 7 shows the parameter estimation results so that the Cox Proportional Hazard Regression equation is obtained, which is as follows:

$$h(t) = h_0(t)\exp\left(-2{,}48546\mathrm{X}_2 - 0{,}88467\mathrm{X}_3 - 0{,}77368\mathrm{X}_4 - 0{,}94917\mathrm{X}_5\right) \quad (8)$$

Simultaneous test obtained the *p*-value Likelihood ratio, which is 0.1e-07, which is smaller than the significance value = 0.05, so the resulting decision H_0 is rejected. The conclusion is that there is at least one independent variable that has a significant effect on the Cox Proportional Hazard model above. A partial test

of the parameters in Table 7 found that the free cash flow variable has no significant effect on the model because the *p*-value > = 0.05. The conclusion is that there are still insignificant parameters to the model, so parameter estimation was carried out to find the best model.

3.5 The Best Model Parameter Estimation

Estimating the best model parameters is done to find variables that significantly affect the model. The estimation results of the best model parameters can be seen in the following table.

Table 8. Estimation of the Best Model Parameters

Variable	Coef	*p-value*
Profitability ($\mathbf{X_2}$)	-2,34817	0,217e-04
Firm size ($\mathbf{X_3}$)	-0,75151	0,0276
Sales Growth ($\mathbf{X_5}$)	-0,76957	0,0535
Likelihood ratio		0,1e-07

Table 8 shows the parameter estimation results so that the Cox Proportional Hazard Regression equation is obtained, which is as follows:

$$h(t) = h_0(t)\exp\left(-2{,}34817X_2 - 0{,}75151X_3 - 0{,}76957X_5\right) \quad (9)$$

Simultaneous test obtained the *p*-value Likelihood ratio 0.1e-07. It is smaller than the significance value $\alpha = 0.05$, so the resulting decision H_0 is rejected. The conclusion is that at least one independent variable has a significant effect on the Cox Proportional Hazard model above. A partial test of the parameters in Table 8 found that the sales growth variable had no significant effect on the model because the *p*-value > $\alpha = 0.05$. The parameter estimation of the model was carried out again because there were still variables that did not have a significant effect on the model, so the estimation of the best model parameters obtained are in table 9 below

Table 9. The Second-Best Model Parameter Estimation

Variable	Coef	*p-value*
Profitability ($\mathbf{X_2}$)	-2,45415	0,828e-05
Firm size ($\mathbf{X_3}$)	-0,8835	0,0127
Likelihood ratio		0,1e-07

Table 9 shows the parameter estimation results so that the Cox Proportional Hazard Regression equation is obtained as follows:

$$h(t) = h_0(t)\exp\left(-2{,}45415X_2 - 0{,}8835X_3\right) \quad (10)$$

Simultaneous test obtained the p-value Likelihood ratio, which is 0.1e-07. It is smaller than the significance value $\alpha = 0.05$, so the resulting decision H_0 is rejected. The conclusion is that at least one independent variable has a significant effect on the Cox Proportional Hazard model above. The partial test that has been carried out results in the profitability and firm size variables having a significant effect on the best model.

3.6 Interpretation of the Cox Proportional Hazard Model

Interpretation of the Cox Proportional Hazard model using the Hazard Ratio value obtained the results as shown in Figure 3 below.

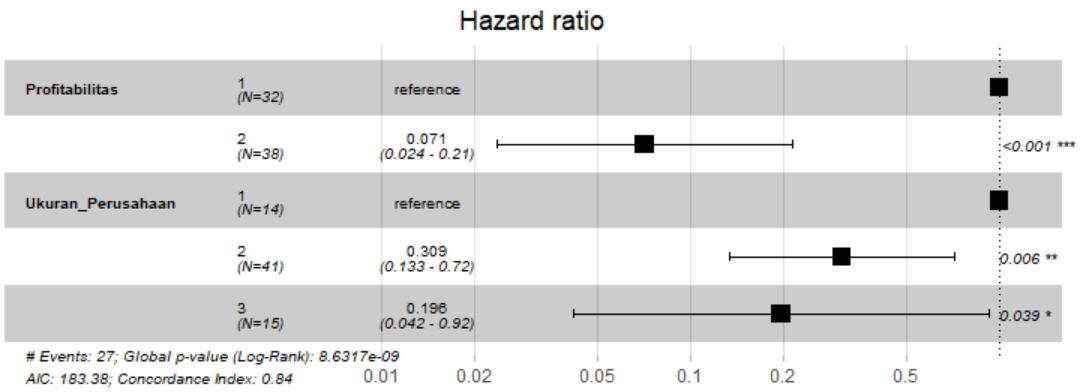


Figure 3. *Hazard Ratio* Value

Figure 3 shows the Hazard Ratio value for the profitability and firm size variables. The value of the Hazard Ratio of profitability variables for each category is $HR_1 = 1$ and $HR_2 = 0.071$. The value of the Hazard Ratio for category 2 (profitability 0.01) is smaller than category 1 (profitability < 0.01), which is 0.071. Therefore, companies with profitability in category 2 (profitability 0.01) have the ability not to experience *financial distress* 0.71 greater than companies with profitability in category 1 (profitability < 0.01).

The value of the Hazard Ratio of the firm size variable for each category is $HR_1 = 1$, $HR_2 = 0{,}309$, and $HR_3 = 0{,}196$. The value of the Hazard Ratio variable for the smallest firm size variable is the firm size variable category 3 ($31{,}5 \leq$ *size* < 35), which is 0.196. It can be interpreted that companies with firm size in category 3 (31.5 size < 35) have the ability not to experience *financial distress* 0.196 times greater than companies with firm size 24.5 size < 28 and 28 size < 31 ,5.

4. CONCLUSION

Based on the results of the analysis of financial distress predictions on financial sector service companies listed on the Indonesia Stock Exchange (IDX) in 2016-2020 using Cox Proportional Hazard Regression, the conclusion is obtained:

a. Factors that significantly affect the model in predicting companies experiencing financial distress are profitability and firm size.
b. Every increase in the value of profitability and the value of the size of the company owned by a company, the company is at risk of experiencing minor financial distress, and vice versa.

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