Predicting Financial Distress Companies in Malaysia Manufacturing Industry Using Logistic Regression and Decision Tree Analysis

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Abstract

When a company is considered to be under financial distress and this situation is not handled well the company may face with a bad reputation and also it will lead to bankruptcy. In the worst case scenario the company can be forced into liquidation. Because of that being aware of financial distress signal is vital for a company in order to maintain a good situation. Thus, prediction of financial distress has been one of the most popular research area in corporate finance. This study recommends a model of financial distress prediction comparing decision tree and logistic regression methods. The dependent variable is dichotomous variables which are distress and non-distress companies listed in Malaysia manufacturing industry. Meanwhile to improve the accuracy of the financial distress prediction model 10 selected financial ratios are used as an independent variable. The sampled data is between 2008-2012. The result proved that decision tree model is the best model since the classification accuracy rate is highest compared to logistic regression models for both training and testing samples. In addition, Total Debt per Total Asset (Debt ratio) followed by Sales per Current Assets (Current Asset Turnover) and Account Receivable per Sales (Average Collection period) is a most significant variable in classifying company status as distress or non-distress company. Overall the results offered provide empirical evidence to support the decision tree method in financial distress warning systems that are useful to most entities in the financial market.

Key Words: Financial Distress, Manufacturing Companies, Decision Tree Model, Logistic Regression Model, Malaysia.

INTRODUCTION

Financial distress is a situation when a company operating cash flow are not sufficient to satisfy current obligation to its creditors within stipulated time. When a company is under financial distress its stocks, bonds and other securities typically experience a significant price drop. This stinging decline happens because most investors are afraid of the company bad reputation. Meanwhile employees of a distressed company tend to have a lower motivation, higher stress, and higher level of procrastination caused by such a burden. This can have caused decreasing in company productivity. Productivity and profitability have a strong positive correlation which decreasing in productivity can make the profit margin for the company is low. Poor profit indicates that the company is facing with higher business risk which it can reduce the creditworthiness with lenders, suppliers, investors and banks. According to (Khaliq, Altarturi, Thaker, Harun, & Nahar, 2014), financial distress companies can incur cost like higher cost in financing, opportunity costs of projects and less dynamic employees. Thus, the company cost of financing additional capital will normally rise, making it more challenging and expensive to raise the fund needed. To fulfill the short-term obligations, a company will run a longer-term profitable project. If this situation cannot be relieved it can lead the company to bankruptcy.

In corporate finance, financial distress has become an important research field which is an extensive ongoing research topic (Sun, Li, Huang, & He, 2014).The ability to predict financial distress as early as possible is important to the companies themselves, a matter of considerable interest to investors, creditors, auditors and other stakeholders. There are many warning signal that show a company is experiencing financial distress. Being aware of these signals can help to avoid financial distress and future bankruptcy. It is because the number of Bankruptcy Company is important for the economy of a country and it can be viewed as an indicator of the development and strength of the economy (Chen, 2011). Besides that, different industry faces a different level of competition and the possibility of financial distress can differ for a company in a different industry. This study is based on companies in the manufacturing industry. Based on Tenth Malaysia Plan, (2011-2015) the performance of manufacturing industry has been generally inspiring with growth in Gross Domestic Product (GDP) and exports. Nonetheless the share of Malaysia manufacturing export in the world market is weakening, facing rigid competition from emerging countries such as the People Republic of China, Vietnam, and China. Issues affecting manufacturing sector are low productivity, the pervasiveness of low value-add labor intensive industries, lack of innovation and competitiveness, and weak enablers. In order to remain competitive, the manufacturing sector will be restructured and focus will be on quality, performance – based incentives, and further promoting exports in the Eleventh Malaysia Plan, (2016-2020).

This study aims to develop financial distress prediction model in the manufacturing industry in Malaysia using Logistic Regression and Decision Tree Analysis and also to describe the characteristics of a company that is more likely to go into financial distress.

The outline of the remaining paper is structured as follows. A brief overview of literature is provided in section 2. Section 3 explains about methodology involved followed by analysis of the finding in section 4. This paper end with conclusion and recommendation in section 5.

LITERATURE REVIEW

Overview of financial distress

A review of literature on the definition of corporate financial distress is wide, covering many definitions of what creates financial distress. Financial distress and then the subsequent failure of a business is usually inflated and disruptive event. (Chen, 2011) defined financial distress company as a company that has filed for bankruptcy. Meanwhile, (Khaliq et al., 2014) define a distressed firm as a firm involved with high fixed costs, assets are illiquid, or revenues that are too sensitive to economic recessions.

Overview of financial distress model

Logistic Regression: According to (Othman & Jaizah, 2012) logit models are employed to discover the explanatory factors behind a certain event which investigate the relationship between binary or ordinal response probability and explanatory variable. (Hui & Milind, 2015) in their study they used logistic regression in predicting financial distress in Hong Kong. Debt to total assets ratio, gross profit and liquidity ratio has been used in the prediction. Results show that the debt to total assets is positively associated with the probability of financial distress. Therefore, the firm with high total debt to total assets will have high possibility to be listed as financial distress company compared to those with a low amount of debt to total assets. Meanwhile, the study also found that the gross profit rate and current ratio are negatively related to the probability of financial distress. Company with low probability to become financial distress will have no problem in paying their obligation as well as to generate high sales.

Meanwhile, according to (Alifiah, Salamudin, & Ahmad, 2013) debt ratio, total assets turnover ratio, and working capital ratio are the most useful ratios for the prediction of financial distress companies in the consumer products sector in Malaysia. They found that by using financial ratio as the independent variables, the prediction model provided more than 50% chance that the model is accurate for five years before distress. In addition (Alifiah et al., 2013) also done a research in predicting financial distress companies in the trading and services sector in Malaysia. The result shows that debt ratio, total assets turnover, working capital ratio and net income to total assets can be used in predicting financial distress. Both studies the researcher used logistic regression analysis.

A study on Evaluating Company Failure in Malaysia has been done by (Yap, Munuswamy, & Mohamed, 2012) The study concludes that logistic regression is still a very effective and consistent statistical tool because it has developed a strong model with very high average accuracy rates which are 88% and 90% for the analysis and the hold-out samples respectively. Instead of that, the study found cash flow to total debt, total debt to total assets, and retained earnings to total assets have significant selective influence in evaluating failure prediction. In addition,(Ong, Yap, & Khong, 2011) logistic regression is a reliable analysis that can be used to predict financial distress company with 91.5 percent predictive accuracy. Instead of that, results show that current asset turnover, asset turnover, average collection period, cash flow to total debt and debt ratio have been found as significant and useful in prediction of financial distress company.

(Loo, Mat Nor, & Yatim, 2001) conducted a study on predicting corporate financial distress using logit model by using 26 distressed companies and 42 non-distressed companies (randomly selected) based on 9 different industries. Results indicated that probability of financial distress is directly related to sales to current assets and current assets to current liabilities. In another study done by (Hui & Milind, 2015) they used Logistic regression and Jackknife method's validation to measure accuracy of the model and results shows that 53.33% are correctly classified as distressed firm (24 firms out of 45 distressed firms) and 85.71% are correctly classified as non-distressed firm (90 firms out of 105 non-distressed firms). (Nanayakkara & Azeez, 2015) used existing Altman's Z-score model to develop better financial distress predicting model for companies listed in Colombo Stock Exchange for the period from 2002 to 2011. The result shows, the model that been developed able to predict financial distress of Quoted public companies in Sri Lanka by 85.8% accurately while predicting distress firms by 91% accurately. Besides, the study also found that retained earnings to total assets, cash flow from operations to total debt, and firm size also identified as better predictors for predicting distress. Besides of predicting financial distress for companies, there also a study was done in the banking sector. (Al-Saleh & Al Kandari, 2012) used logistic regression as a method in predicting financial distress for Commercial Banks in Kuwait. Eleven ratios that been used in the study and only three is found to be significant in predicting financial distress which are an investment in securities to total assets, loans to total assets and loans to deposits.

Decision Tree Analysis: Instead of logistic regression, recently, decision tree also one of the popular analysis in predicting financial distress. (Delen, Kuzey, & Uyur, 2013) used a decision tree to analyzed the impact of financial ratios on firm performance. They found that earnings before tax to equity ratio and net profit margin are important variables that can be used in measuring firm performance. The result explained that the higher the ratio is better for the firm since it shows that the firm has ability to control their cost and expenses. Besides, the study also found that assets turnover ratio and debt ratio had the highest impact on predicting instead of the two ratios as mention above. Debt is one of the company sources of financing, and if the sources invested appropriately, thus will increase the firm's performance. Meanwhile, for asset turnover ratio, the higher ratio is good for the company.

(Kim & Upneja, 2014) used a decision tree to predicting financial distress among publicly traded U.S restaurant for the period of 1988 to 2010. The study found an increase in debt will expose the restaurant towards financial distress. Instead of that, the model explained financial distress restaurant recorded low current ratio as well as net profit margin compared to non-distressed restaurants. Besides that, lack of capital efficiency actually will increase the possibility of the financial distress (Kim & Upneja, 2014).

Logistic Regression and Decision Tree Analysis: On the other hand, (Chen, 2011) used decision tree classification method and logistic analysis techniques to implement the financial distress prediction model. The study found that decision tree classification approach acquires better prediction accuracy than the Logistic Regression approach in a short run period, meanwhile for the long run period; Logistic Regression provides the better prediction than decision tree.

METHODOLOGY

Population and Sample Selection

The samples adopted in this study are companies listed as financial distress by Bursa Malaysia under the requirements of PN4, PN17 and Amended PN17. Therefore, this study also pools data for five years before a company was listed as financial distress by Bursa Malaysia under the requirements of PN4, PN17 and Amended PN17 respectively. A total of 27 companies is taken as a sample comprising 10 distress companies and 17 non- distressed companies. For non-distress companies the sample is taken randomly from listed companies under manufacturing industries. The sample comprises of 11 different sectors under manufacturing industry. The total data set consists of 135 observations whereby there are 85 are healthy company and 50 are delisted company. The sample data was divided into the training and testing samples. The training sample involves of 60% of the total data used to build the models while testing sample consists of 40% of the total data.

Dependent Variable

Financial Distress is a dichotomous variable coded with the value 1 if the company classified as distress, meanwhile for Non-distress Company coded as 0.

Independent Variables

The selections of independent variables are taken from many past researchers listed below:

Description	Measure	Used in past studies
Retained Earnings to Total Assets	Retained earnings / Total Assets	(Nanayakkara & Azeez, 2015)
Cash Flow to Total |Debts	Cash Flow / Total Debts	(Nanayakkara & Azeez, 2015)
Debt ratio	Total debt / Total Assets	(Alifiah et al., 2013), (Khaliq et al., 2014)
TATO	Total Sales / Total Assets	(Alifiah et al., 2013)
Current Assets Turnover	Sales / Current Assets	(Ong et al., 2011)
Assets Turnover	Sales / Total Assets	(Ong et al., 2011)
Days sales in receivables	Account Receivables / Sales x 360	(Ong et al., 2011)
Cash flow to total debt	EBITDA / Total debt	(Ong et al., 2011)

In this study we compare logistic regression and decision tree analysis for financial distress prediction

Logistic Regression

Logistic Regression is used to describe data and to explain the relationship between one dependent binary variable and more metric independent variables (Hair, Black, Babin, Anderson, & Tatham, 2006). Normally this analysis is conduct when the dependent variable is dichotomous (binary).

Mathematically logistic regression estimates a multiple linear regression functions defined as:

$$logit(p) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \ldots + b_kX_k$$

However, Decision tree models are even simpler to interpret than linear regression.

Decision Tree Model

A decision tree is a graph that uses a tree structure to illustrate every possible outcome of a decision. The aim is to create a model that predicts the value of a target variable by learning simple decision rules inferred from the data features. The top most nodes in a tree are the root node. The tree is created by splitting data up by variables and then counting to see how many are in each bucket after each split (Breiman, Jerome, Olshen, & Stone, 1984).

FINDINGS

The results of the two predictive models are presented below.

Logistic Regression Model Results

The logistic regression model is significant based on the Likelihood Ratio Tests (-2log likelihood = 67.878). The model indicates that three from eight input variables are statistically significant in classifying the company status. The variables are Retained Earning per Total Asset, Total Debt per Total Asset and Sales per Current Assets. The logistic regression result is shown in Table 1.

Table 1. Logistic Regression Results

|	Estimate	Std Error	Exp(B)	P-Value
(Intercept)	-0.9982	130.3	0.3685	0.4435
RETAINED_EARNING_PER_TOTAL_ASSET	-438.6	188.4	0.0125	0.0199*
CASH_FLOW_PER_TOTAL_DEBT	-135.7	156.8	0.2573	0.3868
TOTAL_DEBT_PER_TOTAL_ASSET	455.3	186.7	94.8894	0.0148*
TATO	-0.000	0.0003	1	0.9939
SALES_PER_CURRENT_ASSET	-102.5	0.3924	0.3587	0.0090*
SALES_PER_TOTAL_ASSET	0.8747	0.7623	2.3981	0.2512
ACC_RECEIVABLE_PER_SALESX360	-0.007	0.0068	0.9935	0.3397
EBITDA_PER_TOTAL_DEBT	0.5535	0.3173	1.7393	0.0811

Decision Tree Model Results

A decision tree is displayed in a simple, easy-to-understand format. Each branch of the decision tree represents a possible decision or occurrence. The model showed that only three variables are significant in classifying company status. The most predictive variables are the Total Debt per Total Asset followed by Sales per Current Assets and Acc Receivable per Sales. The decision tree rules are listed in Table 2 while Figure 1 shows the decision tree model.

Table 2. The Decision Tree Rules

Delisted Company	Healthy Company
● Total Debt per Total Asset is greater than or equal to 0.3867 ● Sales per Current Assets is less than 1.2924	● Total Debt per Total Asset is less than 0.3867
● Total Debt per Total Asset is greater than or equal to 0.3867 ● Sales per Current Assets is greater than or equal to 1.2924 ● Acc Receivable per Sales is less than 21.4902	● Total Debt per Total Asset is greater than or equal to 0.3867 ● Sales per Current Assets is greater than or equal to 1.2924 ● Acc Receivable per Sales is greater than or equal to 21.4902

Figure 1. The Decision Tree Model
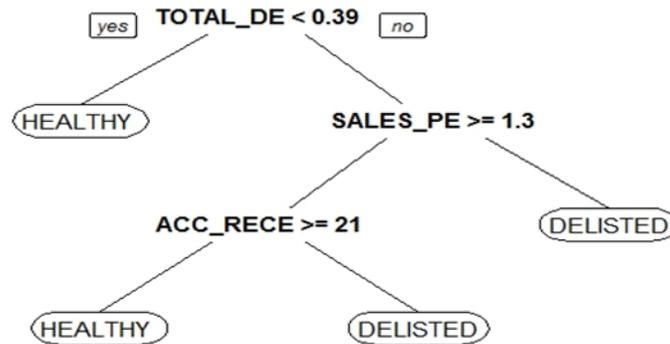
Model Comparisons

The results of Decision Tree and Logistic Regression models are summarized in Table 3 where the classification rate for both the training and testing samples are compared.

Table 3. Accuracy Rate

Model	Training	Testing
Logistic regression	77.50%	70.91%
Decision tree	**86.25%**	**74.55%**

Decision Tree is the best model in classifying the company status since it gave the highest accuracy rate for both the training and testing samples. However, the findings of this study cannot be compared with the findings of previous studies because none of the previous studies specifically stated that they were conducted using Logistic Regression and Decision Tree Analysis except (Chen, 2011) their finding shows that Decision Tree classification approach acquires a better prediction accuracy than the Logistic Regression approach in a short run period.

CONCLUSION

This study develops a prediction model of financial distress companies in the manufacturing sector in Malaysia using logistic regression and decision tree. The result indicates that decision tree model is the best model since the classification accuracy rate is highest compared to logistic regression models for both the training and testing samples. The most predictive variable that had been found to be significant in the manufacturing sector is Total Debt per Total Asset followed by Sales per Current Assets and Acc Receivable per Sales. However, the performance of the two predictive models is not high enough. Overall these results may have important implications for

companies. Some limitations arise in this study since the dataset is not large enough. For future studies, the researcher should include more dataset and explored different types of explanatory variables from other sources to classify a better result. Future research also may add different artificial intelligence techniques, such as survival analysis and others could also be applied. Moreover, future studies should conduct on the financial distress companies in other individual industries in Malaysia such as electrical and electric industries.

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