

## Predicting Financial Distress Using DEA and Altman's Model On Steel and Iron Industry Indonesia

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### ABSTRACT

**Research purpose** - Financial distress is a company's inability to meet their financial obligation, which finally leads to going bankrupt. Financial distress is then used as an early warning signal before going bankrupt. Therefore, financial distress should be predicted as preventive actions. This study main objective is to compare the traditional predictions tools, Altman's Z-score model, with the new propose Data Envelopment Analysis (DEA) approach method.

**Methods** – Focusing on Indonesia steel and iron industry, this study examines using 7 steels and iron companies which listed in IDX from the period of 2013- 2018. Starting from constructing the model of DEA in predicting distress, the accuracy test of both models is compared.

**Result** - The results reveal that DEA's approach prediction has a higher accuracy rate compared to the Altman's model. DEA with a total of 39 correct predictions out of 42 samples generate an accuracy rate of 92.86%. This rate is higher than the Altman's model with the accuracy rate of 85.71% which resulting from a total of 36 correct predictions out of 42 samples.

**Originality / value** – The method, especially DEA to predict financial distress for Steel and Iron Companies in Indonesia is the significant contribution to science.

**Keywords:** *Altman (Z-Score), DEA, Financial Distress*

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### INTRODUCTION

Many aspects that must be a major concern for the government of a developing country to continue to grow independently and become a strong country, crucial factors such as the level of good economic stability, infrastructure, education and the development of science and national industry are some aspects of many other aspects that must be considered by the government, in order to accelerate development and of course to improve the level of welfare of its people (Spacey, 2018).

One of the economic indicators that people widely used in this world to measure economic growth is the Gross Domestic Product (GDP). Conventionally, GDP growth in a country usually measures the growth of the country economically. In short, GDP is the monetary value of all the finished goods and services created inside a country's borders in a particular time period and incorporate anything created by the country's citizens and nonnatives inside its borders (Isnowati,S.,2014).

Besides GDP, going specifically inside the country, one of the indicators of whether economy of a country in the world is strong or not currently and in the future can be seen from the strength and sturdiness from the structure and performance of the iron and steel industry owned by a country (Prasetyo,2010). Supported by the argument of Tambunan (2007), the main industrialization process is encouraged by the steel industry. Countries with advanced industries in the world mostly have an adequate and large steel industry.

Data from the World Steel Association Crude Steel Production Summary 2019 recorded that crude steel production in 2018 was still dominated by China, with a production of 920 million tons (Mt) per year. China's steel production is more than 100 times Indonesia's steel production, which is only 6,2 million tons per year. In several countries, the steel and iron industry have a special treatment

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to become competitive and developing in the global market such as China and Malaysia, for example. China, as the largest producer of steel in the world, is giving a tax rebate from 9% to 13%. Through this incentive, the production cost of steel in China is managed to control at an exceptionally low level. China is still consistent in this tax rebate even it is accused of dumping. The same thing in Malaysia, protection for the local steel industry is charging custom tariffs for 25% in import and regulation for the consumer to use at least 40% of locally produced steel.

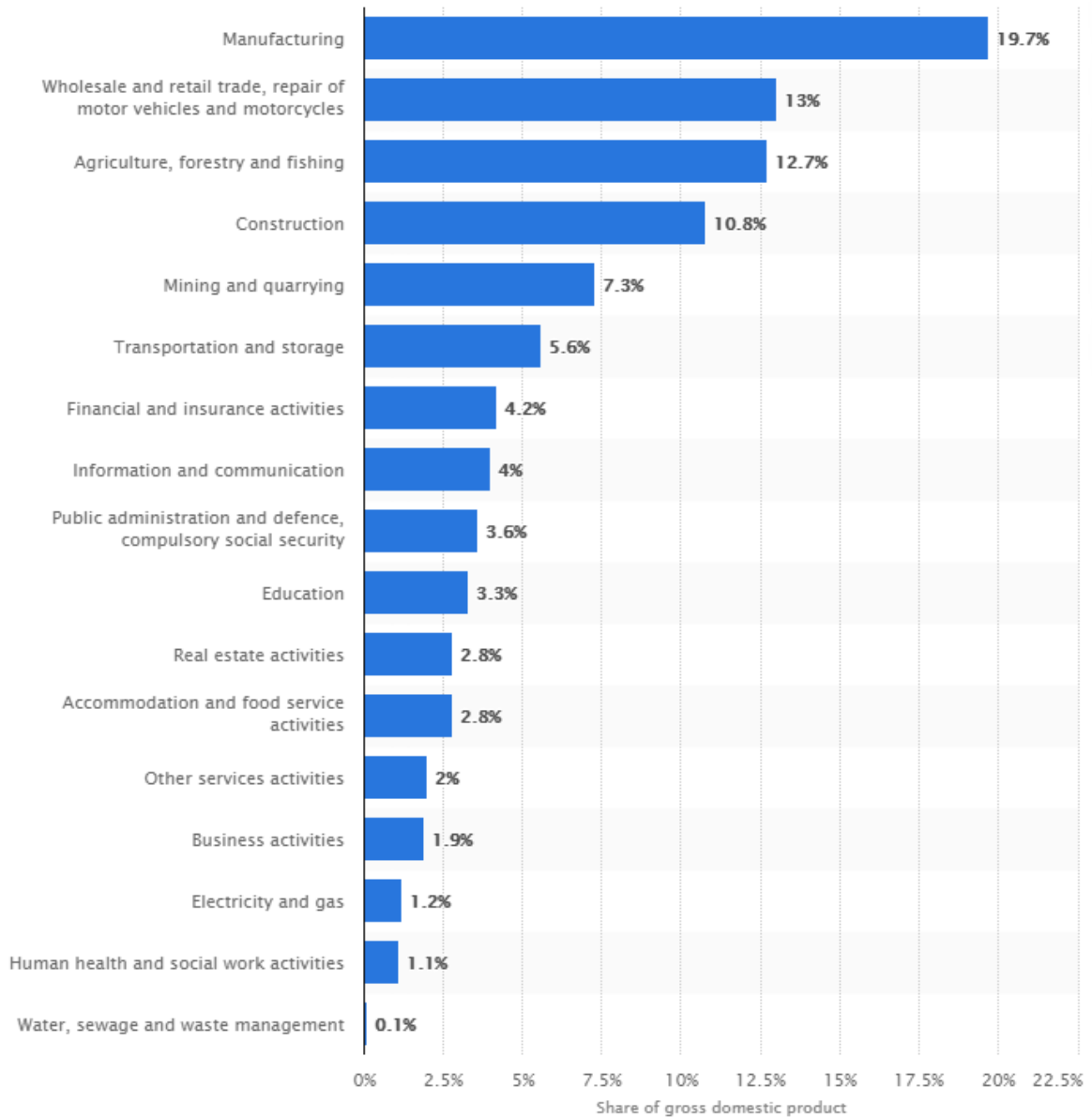
The trade war between the US and China as two of the largest economy in the world had created many impacts on another country and make China shift its export market to other countries. One of China's target markets is including Indonesia. Real GDP growth is a year-to-year comparison of the value of all goods and services produced in an economy expressed in base-year prices.. During the period of 2000-2018, ASEAN's economy grew steadily with an average annual growth of 5.3% (Table 1.1). Among Members ASEAN (AMS), Myanmar, Cambodia, Lao PDR and Viet Nam recorded the highest GDP growth with average annual growth of 9.8%, 7.7%, 7.1%, 6.6 % respectively. Indonesia is only ranking 5 out of 10 AMS.

**Table 1. Indonesia GDP growth compared to neighbor's country based Real GDP growth rate, 2000-2018**

	GDP growth rate (%)					Annual average 2000-2018
	2000	2005	2010	2015	2018	
Brunei Darussalam	2.9	0.4	2.6	-0.4	0.1	0.8
Cambodia	8.4	13.6	6.0	7.0	7.5	7.7
Indonesia	5.4	5.7	6.2	4.9	5.2	5.3
Lao PDR	5.8	7.3	8.1	7.3	6.3	7.1
Malaysia	8.9	5.3	7.4	5.0	4.7	5.1
Myanmar	13.7	13.6	9.6	7.0	6.8	9.8
Philippines	4.4	4.8	7.6	6.1	6.2	5.4
Singapore	8.9	7.5	15.2	2.2	3.1	5.2
Thailand	4.5	4.2	7.5	3.1	4.1	4.1
Viet Nam	6.8	7.5	6.4	6.7	7.1	6.6
ASEAN	6.0	5.8	7.5	4.8	5.2	5.3

**Source:** ASEAN Secretariat, ASEANstats database

Despite the high steel demand nationally and globally, the condition of the structure and performance of the Indonesia iron and steel industry still need a lot of concern, because of not showing productivity competitiveness (Prasetyo,2010). Based on data from the (World Steel Association Crude Steel Production Summary 2019), globally, the competitiveness of Indonesia steel production Indonesia has ranked 25th with an index relatively low in consumption with only around 52 kg per year. Compare to ASEAN neighbor country, Singapore has the highest level of steel consumption per capita with 488 kg, followed by Malaysia 299 kg per capita, Thailand 239 kg per capita, Vietnam 227 kg per capita, Philippines 94 kg per capita.



**Figure 1. Sector contribution in Indonesia GDP 2019 in percent**

Source: Statistika.com

By looking further into the detail and the composition of Indonesia's GDP as revealed in Figure 1.2, that the GDP of Indonesia is highly contributed by the manufacturing sector. Manufacturing had contributed 19.7% of Indonesia's total GDP. Hence, the manufacturing sector is particularly important to Indonesia's growth. The steel industry is expected to be a base for industrial development mainstay, especially for the development machinery industry, conveyance industry, the electronics and telematics industry, building/infrastructure sector. Because the role of this industry is particularly important, then the development of the iron and steel industry is very strategic to push the prosperity of a country.

Indonesia steel industry is facing a very dangerous position; despite the inability to provide the demand nationally, the local product is losing its market due to the lower price offer by China as a country which exports their steel to Indonesia. What doubled up the condition is due to the impact of the trade war that makes China reallocate their target market to Indonesia. In accordance with the phenomenon already explained above, the authors have drawing concern on the steel and iron industry in Indonesia.

Financial distress is defined by when a company is unable to fulfill its debt requirements, that is going to default and moving into bankruptcy, while experiencing liquidation and another form of asset seizure and distribution (Sun, *et al.*, 2014). Financial distress is a situation where a business has certain kind of financial difficulties. Classically, such financial difficulties include inability to settle debts and obligations of the business and may even lead to the more severe consequences of bankruptcy and liquidation. A business under financial distress can incur costs such as more expensive financing, forced asset selling, opportunity costs of projects lost, less productive employees and bankruptcy costs etc. Employees of a distressed company usually have lower morale and higher stress caused by the increased chance of bankruptcy, which could force them out of their jobs (Latif, Usman, 2018).

There are several traditional tools, such as Altman (Z-Score), Springate (S-Score) dan Zmijewski (X-Score). One of the popular prediction models that have been used by a lot of researchers around the world is the Altman (Z-score) model by a professor from New York University, named Edward I. Altman, in 1968. Altman's model combined several key financial ratios of a company to predict the financial distress (Altman, 2001). Almamy *et al.* (2016) found that the prediction accuracy of the original Z-score model declined with the passage of time for the UK market and point out that Altman (1968) was developed with limited data and by searching for the right variable. In contrast, Ashraf *et al.* (2019) research proof that Altman Z-score is still valuable for predicting the financial distress of emerging markets.

In recent years, academics raising attention to the role of corporate efficiency (Paradi *et al.*, 2004) and have begun to study their relationships to financial distress. DEA, a non-parametric method, had been widely used as a tool to measure efficiency and come up with its own advantage while dealing with a relatively small sample. Two ways input and output considerations make DEA considered balance out the limitation of traditional methods. DEA effectiveness cannot foresee financial distress well sufficient without the information of financial ratios because financial ratios are still powerful and dominant in their explanatory ability (Li, Z, et al., 2014). Therefore, the researchers used the DEA approach to predict the financial distress of the company by using related financial data that may reflect the financial health of the company in the predicting process.

The main purpose of this research is to validate the new approach (DEA) in predicting financial distress and compared it with the well-known traditional tools, Altman Z-score. The results of both methods in predicting financial distress are compared. Due to the availability of data and limitation of time, the researchers focuses on conducting the research on companies in Indonesia that are classified into Steel and Iron industry by Indonesia Stock Exchange, which publish an annual report with the period of time from 2013 until 2018.

## **METHODOLOGY**

This research employs quantitative method to get quantifiable data then analyze it by tools. In accordance to provide information to fulfill the research needs, it necessary for the researchers to use a method called sampling design which help the researchers or authors of this research in determining the sample of the study (Hassan, 2016).

A sample can be defined as a group of a relatively smaller number of people or things selected from a population for investigation purpose, with clear and focus sample from the selected population, this research generate a result with high accuracy level. There are several phases of sampling design which is commonly used for defining the population, determining the sampling method, and determining the sample size of research.

In the accordance of the population definition that identified as the group of elements or people that meet the particular characteristic for a research investigation (Alvi, 2016), the population in this research are the companies which belong to the subsector of metal and allied products industry listed in IDX. A total of 16 companies are listed under IDX in metal and allied product.

The sampling technique utilized by researchers is purposive sampling, a sampling prepares which decided by a certain criterion (Siregar, 2013). To optimize the sample size of this research, the researchers have arranged several criteria for the sample size of this study to maximize the efficiency and reliability aspects from the sample itself (Sugiyono, 2015).

These are the following criteria or characteristic needed by the authors in determining the sample size of this research:

1. The company has been going public and listed on the IDX.
2. The company which published its audited annual financial report from 2013 – 2018.
3. The company stock has never been suspended from IDX.
4. The company has all cash flow activities that help the author to define their financial condition.

Based on the determined criteria or characteristic above, researchers select 7 (seven) out of 16 (sixteenth) companies in Indonesia that belongs to the steel and iron industry. The data observations have chosen 42 (forty-two) observations data in total as revealed in Table 2.

Regarding to the objectives of this research in determining the accuracy level of traditional method using Altman Z-score and new method using DEA in financial distress prediction, the sample is needed to be defined their current financial condition. In this research, as revealed in Table 2.2. the sample is further divided into two which are the companies in a stable condition or can be concluded as non-distressed and distressed condition. The determination of current financial condition is based on earning information and their cash flow pattern. These two financial distress indicators theories are supported by many previous researches. According to Oz & Yelkenci (2017), earning components has a high level of prediction accuracy based on analyzed theoretical model. Other researchers such as Shamsuddin, A and Kamaluddin, A (2015) stated that cash flow pattern is more reliable compared to the information of earning in identifying distress condition.

**Table 2. Sample Size**

No	Company	Stock Code	2013	2014	2015	2016	2017	2018
1	PT Sarana Central Bajatama Tbk	BAJA	1	1	1	1	1	1
2	PT Betonjaya Manunggal Tbk	BTON	1	1	1	1	1	1
3	PT Citra Tubondo Tbk	CTBN	1	1	1	1	1	1
4	PT Gunawan Dianjaya Steel Tbk	GDST	1	1	1	1	1	1
5	PT Steel Pipe Industry of Indonesia Tbk	ISSP	1	1	1	1	1	1
6	PT Lion Metal Works Tbk	LION	1	1	1	1	1	1
7	PT Lionmesh Prima Tbk	LMSH	1	1	1	1	1	1
			7	7	7	7	7	7
			42					

Sources: Adjusted authors (2019)

**Table 3. Financial Condition Determination Criteria**

Financial Condition	Financial Position			
	Earning	Cash Flow Activities		
		Operating	Investing	Financing
Stable/Non Distressed	Net Income (+)	Any Cash Flow Pattern		
	Net Loss (-)	Positive (+)	Positive (+)	Positive (+)
	Net Loss (-)	Negative (-)	Positive (+)	Positive (+)
	Net Loss (-)	Negative (-)	Positive (+)	Negative (-)
	Net Loss (-)	Negative (-)	Negative (-)	Positive (+)
Distressed	Net Loss (-)	Positive (+)	Negative (-)	Negative (-)
	Net Loss (-)	Positive (+)	Positive (+)	Negative (-)
	Net Loss (-)	Positive (+)	Negative (-)	Positive (+)
	Net Loss (-)	Negative (-)	Negative (-)	Negative (-)

Source: Adjusted by Authors (2019)

The researchers use secondary data extract from several resources such as books, journals and official websites for general information and related supported data. In this research, the authors find out the data from annual financial reports of the selected sample, macroeconomics data from official financial websites such as from Bank Indonesia and Bloomberg. There are also references and quotation from books and journals that are published by a trusted publisher. Data processing tools used in this research are Microsoft Excel 2010, a MaxDEA software and SPSS version 25. Microsoft Excel was used to calculate and grouped the data based on definitions that have been defined, application of model used calculation and chart and graph creating. DEA software used to evaluate the envelopment model in predicting the distress and SPSS used to calculate the descriptive statistics analysis.

This section describes the operational definitions of each variable. The first part explained the selected input and output variables using non-parametric DEA approach as revealed in Table 3. The definition and its formula will be stated. On the other hands, the variable of Altman's Z-score is explained as well in the Table 4.

**Table 4. DEA variables**

<b>Model</b>		<b>Variables</b>	<b>Definition</b>	<b>Scale</b>
<b>DEA</b>	<b>Inputs</b>	<b>Total Assets</b>	An asset is defined as something that a business has, has value, and can be converted into cash. Assets are divided into 2 main categories. These 2 categories are current assets and non-current assets. Each class is further divided into several subcategories. Total assets are the total of all current and non-current assets and must equal the total number of liabilities and combined equity.	Nominal
		<b>Total Liabilities</b>	Total liabilities are the aggregate debt and financial obligations owed by a business to people and organizations at any specific period. Liabilities are usually reported in businesses as either short-term liabilities (or current liabilities) and long-term liabilities. Total liabilities are the total of current liabilities and long liabilities and reported on a company's balance sheet.	Nominal
	<b>Outputs</b>	<b>Market Value of Equity</b>	The market value of a company's equity is the total value given by the investment community to business. A company's Market Value of Equity is the current market price of the company's share multiplied by the number of all outstanding shares in the market. The number of shares outstanding is listed in the equity section of a company's balance sheet. This calculation should be applied to all classifications of stock that are outstanding, such as common stock and all classes of preferred stock. The market value of equity is also known as market capitalization.	Nominal
		<b>Earnings Before Interest and Tax</b>	EBIT or income before interest and taxes is a profitability measure that calculates the operating profit of a business by reducing the cost of goods sold and the operating costs of total revenue. This calculation shows the profits the company makes from its own operations without considering interest and taxes. EBIT or income before interest	Nominal

			and taxes is often called operating income.	
		<b>Retained Earning</b>	Profit that is retained inside the company or part or all the profits earned by the company that are not distributed by the company to shareholder in the form of dividends. The amount of profit that is retained can be used by companies to increase capital or to expand the company	Nominal
		<b>Working Capital</b>	Working capital is the amount of an entity's current assets minus its current liabilities or can be defined as money available to a company for day-to-day operations. The result is considered a prime measure of the short-term liquidity of an organization. A strongly positive working capital balance indicates robust financial strength, while negative working capital is considered an indicator of impending bankruptcy	Nominal

**Table 5 Altman's Z-score variables**

Methods	Variables	Definition	Measurement	Scale
Altman's Z-score	WCTA	An estimation to measure the liquidity by focusing on the comparison between total working capital and total assets	$WCTA = \text{Working capital} / \text{Total assets}$	ratio
	RETA	To interpret the cumulative profitability by utilizing company's total assets	$RETA = \text{Retained earnings} / \text{Total assets}$	ratio
	ROTA	ratio to measure the earning's proportion which is efficiently generated using assets	$ROTA = \text{Earnings before interest and tax} / \text{Total assets}$	ratio
	MCTL	The indication to find out how much the company's assets can decrease in value before the liabilities is more than the assets and the companies become failed	$MCTL = \text{Market value of equity} / \text{Book value of liabilities}$	ratio
	STA	Ratio to estimate the ability of a company to generate its sales by using it assets, usually called as asset turnover ratio	$STA = \text{Sales} / \text{Total assets}$	ratio

The authors of this research decided to choose secondary data in collecting necessary data for the research itself. Secondary data will be suitable due to the important data for this research is published financial report of a company which belongs to Indonesia steel and iron industry. In addition, to generate more information related to the chosen phenomenon for this research, the authors decided to use the documentary method as well in analyzing the documents as data required that contain information needed.

To conclude the constructed methods to collect the data by the authors of this research, these are briefly explanation related data collection method for this research:

1. Researcher assesses the data from the IDX data and annual financial report of the companies which belongs to Indonesia steel and iron industry.
2. Researcher identifies the 5 (five) companies that meet the data requirements.

The researchers use DEA approach in this research to predict the financial distress. Basically, the DEA model aims to compare the input and output with other input and output data in the similar DMUs. According to Sufian (2007), the advantage of using DEA is the data will work fine even with small amount of sample size. The most crucial component of the DEA analysis is the construction of the production model. It must capture the actual process as accurately as possible and consider the most relevant inputs and outputs. The importance of the proper variable selection is enhanced by the fact that they will act as a benchmark for all companies and act as targets for firms trying to avoid failure. This section describes the model used for predicting corporate distress and outline the relevance of each variable. The distress prediction model is developed using variables that allow good comparison with the popular Z score method and therefore, neither the model, nor the choice of variables are necessarily the most suitable for the best DEA model for this purpose.

To construct a model, a framework must be developed which represents the viewpoint adopted for this process. The selected variables will then need to be incorporated into the framework, assuring that the resulting model is a fair representation of corporate activity. All companies attempt to maximize their revenues and minimize their costs to achieve the largest possible profit. Within public companies the primary objective of corporate management is generally assumed to be the maximization of stockholders' wealth which requires the maximization of the market price of the firm's common stock. The goal of management, in a sense, is to maximize shareholders value for a firm with an associated net worth.

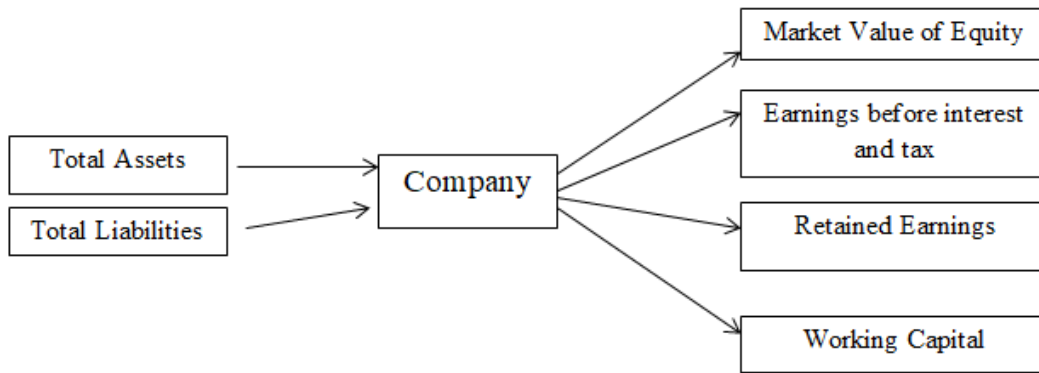


**Figure 2 Management Goals Framework**

This may be achieved by high and growing share value, high revenue, and/or large profitability. If management fails to increase shareholder value, or even depletes it during the operation of a firm, then financial difficulties arise. To allow for an accurate comparison of DEA with an accepted predictive method, the researchers use the ratios taken from the Z score model to formulate the DEA model. The dissection of these ratios into their numerators and denominators gives the variables including Total Asset, Working Capital, Retained Earnings, Income Before Interest and Tax, Total Liabilities and Market Value of Equity.

These variables are chosen and need to be fitted to the framework that had been created before, so that the best possible model is created from a failure prediction point of view. The model created as revealed at Figure 3. Figure 3 revealed that the total assets and total liabilities of the company combine to give an indication of the company's net worth. The market value output is an indication of the market's perception of the company's worth. The maximization of EBIT is a clear goal of the company and its shareholders, as this gives rise to increasing profitability and shareholder value. The retained earnings output gives a historical component to the analysis, as it represents the firm's reinvested earnings, over the years, that have not been paid out as dividends.





**Figure 3 DEA model framework**

If a firm is losing money on a continuous basis its retained earnings are going to be depleted. Working capital is a liquidity measure which firms need to meet current obligations. A lack of liquidity often leads to financial difficulties and can be an indicator of more severe problems to come.

In this study, the researchers employ both the BCC model by Banker, et.al. (1984) to get the measurement under VRS assumptions. It is important to note that the BCC model is both scale and translation invariant. Translation invariance means that the efficiency scores will be invariant to the translation of inputs and outputs by a scalar. Therefore, the researchers used BCC model to get the better result since the data collected need to be translated. Input orientation was selected for this DEA model as it takes the view that for a company with a given market value and a certain earnings level, what is the smallest possible asset base that can be used to generate that given profit level. BCC model is translation invariant if it is input oriented while output is translated, vice versa. Input oriented BCC model is employed in this research.

The implementation of accuracy test is to estimate the correct and incorrect prediction compared to the real financial condition on the selected samples. Accuracy rate is used to define the level of the prediction power in this research. The more accurate the model is, the stronger the prediction ability of the model. The process starts from the researchers calculate the result of prediction in each sample and categorizes their position into the non-distressed and distressed by using each model cut-off point. The number of correct predictions is used to calculate the percentage of correct prediction over all the samples. The formula to calculate the accuracy rate is below:

$$\text{Accuracy rate} = \text{number of correct prediction} / \text{total samples} \times 100\%$$

## RESULTS AND DISCUSSION

DEA scores using selected total asset and total liabilities as the inputs and market value of equity, earnings before interest and tax, retained earnings and working capital as the outputs with BCC input orientation results of each company. The result of each company between 2013 until 2018 as revealed on Table 6 and Table 7:

**Table 6 DEA's score and classification**

Company	Year	DEA's Score	Financial Prediction
<b>PT Saranacentral Bajatama Tbk (BAJA)</b>	2013	0.3700	Distressed
	2014	0.1714	Distressed
	2015	0.1184	Distressed
	2016	0.4512	Distressed
	2017	0.0565	Distressed
	2018	0.0593	Distressed
<b>PT Betonjaya Manunggal Tbk (BTON)</b>	2013	1.0000	Stable
	2014	0.9826	Stable

	2015	0.9412	Stable
	2016	0.9252	Stable
	2017	0.9845	Stable
	2018	1.0000	Stable
<b>PT Citra Tubindo Tbk (CTBN)</b>	2013	1.0000	Stable
	2014	1.0000	Stable
	2015	0.9949	Stable
	2016	1.0000	Stable
	2017	1.0000	Stable
	2018	0.8094	Stable
<b>PT Gunawan Dianjaya Steel Tbk (GDST)</b>	2013	1.0000	Stable
	2014	0.2071	Distressed
	2015	1.0000	Stable
	2016	0.3820	Distressed
	2017	0.2446	Distressed
	2018	0.0625	Distressed
<b>PT. Steel Pipe Industry of Indonesia Tbk (ISSP)</b>	2013	1.0000	Stable
	2014	1.0000	Stable
	2015	0.8778	Stable
	2016	0.8349	Stable
	2017	0.6915	Stable
	2018	0.6361	Distressed
<b>PT Lion Metal Works Tbk (LION)</b>	2013	1.0000	Stable
	2014	0.8677	Stable
	2015	0.9387	Stable
	2016	0.9430	Stable
	2017	0.8712	Stable
	2018	0.9393	Stable
<b>PT Lionmesh Prima Tbk (LMSH)</b>	2013	1.0000	Stable
	2014	0.9892	Stable
	2015	1.0000	Stable
	2016	0.8773	Stable
	2017	1.0000	Stable
	2018	1.0000	Stable

Source: Result from Calculation by authors (2019)

The results scores in Table 6 are used to classify the financial condition of the company depending whether they are above or below the cut-off point. The optimal cut-off point of 0.66 is used in this research referring to the research that had been conducted before, which implies that efficiency scores greater than 0.66 is considered as a table financial condition and scores below than 0.66 is consider distressed.

Based on DEA approach, there are 11 samples are experiencing financial distressed based on the prediction out of 42 samples. On the other hands, the rest of 31 samples are categorized as stable, where the score's is greater than the cut-off point.

While using the traditional tools, Altman's Z-score result calculation as revealed in the Table 6 followed by the prediction result.

The cut-off point of Altman's Z-score is 1.81 in line with the theory. Based on the results of Altman's Z-score prediction as revealed on Table 7, there are 6 samples are experiencing financial distressed based on the prediction out of 42 samples. On the other hands, the rest of 36 samples are categorized as stable where the score's is greater than the cut-off point.

**Table 7 Altman's Z-score and classification**

Company	Year	Altman's Z-Score	Financial Prediction
<b>PT Saranacentral Bajatama Tbk (BAJA)</b>	2013	2.4237	Stable
	2014	1.5239	Distressed
	2015	1.2403	Distressed
	2016	1.6256	Distressed
	2017	1.3638	Distressed
	2018	0.9382	Distressed
<b>PT Betonjaya Manunggal Tbk (BTON)</b>	2013	4.3865	Stable
	2014	4.5649	Stable
	2015	3.5572	Stable
	2016	3.4333	Stable
	2017	4.2165	Stable
	2018	5.8278	Stable
<b>PT Citra Tubindo Tbk (CTBN)</b>	2013	3.8434	Stable
	2014	3.8872	Stable
	2015	3.3169	Stable
	2016	6.0329	Stable
	2017	4.8637	Stable
	2018	3.7373	Stable
<b>PT Gunawan Dianjaya Steel Tbk (GDST)</b>	2013	3.4792	Stable
	2014	2.0616	Stable
	2015	1.3731	Distressed
	2016	2.5906	Stable
	2017	2.3687	Stable
	2018	1.8633	Stable
<b>PT. Steel Pipe Industry of Indonesia Tbk (ISSP)</b>	2013	22.1535	Stable
	2014	27.5891	Stable
	2015	21.5103	Stable
	2016	20.7990	Stable
	2017	11.7594	Stable
	2018	8.2307	Stable
<b>PT Lion Metal Works Tbk (LION)</b>	2013	3.5087	Stable
	2014	2.6337	Stable
	2015	2.6242	Stable
	2016	2.4715	Stable
	2017	2.1216	Stable
	2018	2.2857	Stable
<b>PT Lionmesh Prima Tbk (LMSH)</b>	2013	4.0834	Stable
	2014	3.8376	Stable
	2015	4.6735	Stable
	2016	3.2610	Stable
	2017	4.4640	Stable
	2018	4.4534	Stable

Source: Result from Calculation by authors (2019)

After the classification of each model, the prediction is compared to the real condition of the company to figure out the accuracy rate. Table 8 reveals the actual condition of the company compared to the prediction using DEA and Altman's as follow:

**Table 8 Actual financial position compared to Model prediction result**

Company	Year	Real Condition	DEA Prediction	Altman's Prediction
<b>PT Saranacentral Bajatama Tbk (BAJA)</b>	2013	Distressed	Distressed	Stable
	2014	Stable	Distressed	Distressed
	2015	Distressed	Distressed	Distressed
	2016	Distressed	Distressed	Distressed
	2017	Distressed	Distressed	Distressed
	2018	Distressed	Distressed	Distressed
<b>PT Betonjaya Manunggal Tbk (BTON)</b>	2013	Stable	Stable	Stable
	2014	Stable	Stable	Stable
	2015	Stable	Stable	Stable
	2016	Stable	Stable	Stable
	2017	Stable	Stable	Stable
	2018	Stable	Stable	Stable
<b>PT Citra Tubindo Tbk (CTBN)</b>	2013	Stable	Stable	Stable
	2014	Stable	Stable	Stable
	2015	Stable	Stable	Stable
	2016	Stable	Stable	Stable
	2017	Stable	Stable	Stable
	2018	Stable	Stable	Stable
<b>PT Gunawan Dianjaya Steel Tbk (GDST)</b>	2013	Stable	Stable	Stable
	2014	Distressed	Distressed	Stable
	2015	Distressed	Stable	Distressed
	2016	Distressed	Distressed	Stable
	2017	Distressed	Distressed	Stable
	2018	Distressed	Distressed	Stable
<b>PT. Steel Pipe Industry of Indonesia Tbk (ISSP)</b>	2013	Stable	Stable	Stable
	2014	Stable	Stable	Stable
	2015	Stable	Stable	Stable
	2016	Stable	Stable	Stable
	2017	Stable	Stable	Stable
	2018	Stable	Distressed	Stable
<b>PT Lion Metal Works Tbk (LION)</b>	2013	Stable	Stable	Stable
	2014	Stable	Stable	Stable
	2015	Stable	Stable	Stable
	2016	Stable	Stable	Stable
	2017	Stable	Stable	Stable
	2018	Stable	Stable	Stable
<b>PT Lionmesh Prima Tbk (LMSH)</b>	2013	Stable	Stable	Stable
	2014	Stable	Stable	Stable
	2015	Stable	Stable	Stable
	2016	Stable	Stable	Stable
	2017	Stable	Stable	Stable
	2018	Stable	Stable	Stable

Source: Result from Calculation by authors (2019)

Based on the results on Table 8 revealed that the total of correct prediction of DEA method in predicting financial distress condition reach 39 samples out of 42 samples in total. The incorrect prediction of financial condition is respectively occurred in BAJA 2014, GDST 2015 and ISSP 2018.

Both BAJA and ISSP are in a financially stable condition in the year 2018 while predicted to be in a distressed condition. In contrast, GDST in 2015 is financially distressed while predicted to be stable.

Three incorrect predictions occurred in DEA prediction method. Meanwhile, the total of correct prediction of Altman's Z-score in predicting financial distress is 36 samples out of 42 samples in total. This will leave a total of 6 incorrect predictions using this method. The incorrect prediction is occurred in BAJA year 2013 and 2014, GDST year 2014, 2016, 2017 and 2018. Only in 2014, BAJA is predicted to be in distressed condition while it is stable. The rest of 5 cases, the prediction is incorrect due to the real condition is in the distressed while predicted to be financially stable.

Comparing both prediction methods, the incorrect prediction that occurred in both methods is only happens in the case of BAJA in 2014. In 2014, BAJA financial condition real condition is categorized as stable while both methods predicted it to be in a financial 5 distressed. Furthermore, the rest of incorrect prediction occurred in different timeline and company. Therefore, the total accuracy rate is calculated and presented in table 9.

**Table 9 Accuracy Rate of DEA and Altman's Prediction**

<b>Prediction Model</b>	<b>Total Correct Prediction</b>	<b>Total Sample</b>	<b>Total Accuracy Rate (%)</b>
DEA's Prediction	39	42	92.86%
Atman's Prediction	36	42	85.71%

Source: Summary of the Calculation

By using 42 samples in Indonesia steel and iron industry from 2013 to 2018, DEA's approach prediction has a higher accuracy rate compared to the Altman's model. As revealed at Table 3.4, DEA with a total of 39 correct prediction out of 42 samples generate an accuracy rate of 92.86%. This rate is higher than the Altman's model with the accuracy rate of 85.71% which resulting from a total of 36 correct prediction out of 42 samples. This result is then validated that the DEA's efficiency scores approach can be used in predicting the financial distress and have a better power compared to the Altman's model.

## CONCLUSIONS

The DEA model was developed based on a framework representing the view point of the shareholders and investors' goals where there is a maximization of the shareholder value through the market value of equity output and others earning such as earnings before interest and tax and retained earnings. Finally, the liquidity output indicator using working capital. The choice of variables for the model was selected based on the related financial indicator from Altman's Z-score model to have an 'apple to apple' comparison. The researchers selected traditional Altman model for the comparison because it is a most common tools used in predicting financial distress. The distressed and non-distressed classification accuracies of the DEA model were compared against the Z score model.

From the accuracy test, DEA turn out to have a better predicting power compared to traditional Altman's model. This high accuracy rate is probably supported by the crucial selection of inputs and outputs variables. Perhaps, the working capital output, that measure the liquidity which usually related to the financial health take a meaningful contribution and have a big impact in predicting distress and contribute to the increase of accuracy rate. Through this result, DEA model seems to be an appropriate tool to predict the financial distress. DEA is relatively new non-parametric method compared to other conventional technique, where is commonly apply in calculating the efficiency of manufacturing production and bank efficiency. DEA allows the researchers to evaluate individual units with respect to the whole sample. The limitations of this study caused by the availability of the financial data in Indonesia steel and iron industry. There are 42 (forty-two) samples are selected after filtering using the criteria set. To summarize, these results have demonstrated the discriminatory power of DEA and it shows a very promising signs of be able to classify distressed and

non-distressed companies. This result contributes to science in predicting financial distress especially for iron industry in Indonesia.

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