ANALYZING INDONESIAN CEMENT COMPANIES’ EFFICIENCY USING THE STOCHASTIC FRONTIER ANALYSIS METHOD PERIOD 2014-2018

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ABSTRACT
Cement industry is one of the important industries in supporting the country’s development. However, the level of cement utilization in Indonesia in 2014–2018 experienced a fluctuating growth. In 2014–2016, the decreased revenue growth had been followed by the decreased growth in net profit margin and return on assets, while the increased revenue growth in 2016–2018 was not followed by the increased growth in net profit margin and return on assets. Therefore, it is necessary to analyze the company’s efficiency to maintain its performance. The results of this study indicate that the variable of raw materials cost had a significant negative effect on efficiency, variable of labor cost, total assets, revenue, and interest rates had significant positive effects on efficiency, while return on equity and return on assets had no significant effect on efficiency. The most efficient cement company was Semen Indonesia, Ltd with a value of 0.93609 and the least efficiency one was Semen Baturaja, Ltd with a value of 0.09772.

INTRODUCTION
Cement utilization is one of indicators in a country’s economic growth. Panggah Susanto, The General Director of the Manufacturing Industry Base in the Ministry of Industry (2012) explained that the demand for cement always increased every year, driven by infrastructure development, starting from the construction of roads, housing, high rise buildings, and other projects. The program implementation of the Master Plan for the Acceleration and Expansion of the Indonesian Economic Development (MP3EI/Master Plan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia) designed by the government for the period of 2011–2025 would shift the tremendous demand for cement out of Java. Anticipation that can be made related to this condition is that the performance of the cement industry must be encouraged to ensure the availability of commodity supply in the country, especially outside Java.

Efficiency is the act of maximizing results using capital, such as minimum labor, materials, and equipment (Imhanzenobe, 2019; Seth et al., 2020). This efficiency measurement is used to simply identify the efficiency measure in a company. Farrell (1957), who collaborated with Debreu and Koopmas, invented a modern method of efficient measurement for the first time.

Stochastic Frontier Approach (SFA) is a functional form showing the relationship of costs, profits, or production to input, output, and environmental factors (Satyagraha et al., 2022; Shen et al., 2023). SFA method has two types of errors namely random error and cost inefficiency. Random error is assumed to follow the symmetrical standard distribution, while cost inefficiency is assumed to follow the asymmetric distribution (Berro, 2023; R. Hendrawan et al., 2019). The frontier method sets limits on the data being tested and is used as a benchmark against the
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performance of the measured variable (Sotiros et al., 2022; Veiga et al., 2021). In the frontier method, all variables used must be able to operate at the specified efficiency level in accordance with the results of the efficiency in the sample (Jin & Kim, 2019; Sidhoum et al., 2023). This method compares the ratio of input and output. Comparison of efficiency by using the frontier method has a derivative, namely the parametric statistical method and non-parametric statistical methods (A. Hendrawan et al., 2010).

Moriwaki et al. (2009) conducted a study on telecommunication companies in Asia Pacific. The method used in this study was Stochastic Frontier (SF), using panel data with the 1993–2004 period. The variables were revenue, capital costs, the number of workers, and the number of customers. The data was processed by using Frontier 4.1 tools. The result of this study was that the value of technical efficiency of telecommunication companies in the Asia Pacific was lower than telecommunication companies in developed countries like the United States. Factors affecting the value of technical efficiency in telecommunication companies in various countries were population, the number of handsets with total subscriber, company privatization, and the level of internet usage trends.

Ngan (2014) conducted a study using SFA approach to measure costs and profit efficiency in 45 commercial banks in Vietnam starting in 2007–2012 period using input price of physical capital, prices of labor, price of loanable funds, net loan output, and total securities. This study focused on risk and asset quality factors associated with the cost inefficiency and bank profits. This cost inefficiency appeared to be strongly related to bank concentration, mergers, and bank ownership. Based on the results of variance analysis tests, state-owned commercial banks were more efficient than other domestic banks. International banks were leading in cost efficiency than other national banks.

Yudaruddin (2017) examined the study of various factors affecting the efficiency of Bank Pembangunan Daerah in Indonesia using Stochastic Frontier Analysis (SFA). The data were panel data sourced from Bank Indonesia and the Central Statistics Agency (BPS/Badan Pusat Statistik) for 2009–2015. Data were analyzed by using panel data regression with the E-Views 8 program. The results of this study found that (1) bank profitability as measured by ROA had a significant negative effect, (2) net interest margin (NIM) had a significant positive effect, (3) risk variables had a significant positive effect, and (4) bank stability had a negative and not significant effect. The size of the bank and third-party funds (DPK/Dana Pihak Ketiga) did not significantly influence bank efficiency. The Gross Domestic Product (GDP) variable showed significant positive results, whereas the inflation variable was discovered to have a negative and not significant effect on efficiency.

Hendrawan and Nasution (2018) conducted a study on the banking sector playing an important role in the Indonesian economy to measure the level of efficiency of the banking system. The purpose of this study was to determine the efficiency of 21 banks on the Indonesia Stock Exchange in 2008–2017 using SFA. The findings of this study indicated a maximum efficiency score of 0.69 and the average bank score among the study samples with the allocation of inputs and outputs that could generate profits was 0.69 - 0.43 = 0.26. Overall the banking sector on the
Indonesian capital market in 2008–2017 recorded an efficiency score of 0.43. With this score, the banking system on the Indonesian capital market was still considered inefficient (0.43 < 0.5). The result of this study indicated that several output variables, such as total loans (Y1) and securities (Y3), and input variables such as labor prices (W2) and inflation (Z), had a significant effect on bank profits. Meanwhile, input variables such as variable fund prices or total funds (W1) and physical capital prices were reflected in depreciation of fixed assets (W3), and output variables of income and interest (Y2) had insignificant effect on bank profits.

Imran (2018) conducted a study on Bangladesh financial sector banking industry. This study used a single stage SFA to measure cost efficiency in Bangladesh banking sector in 2011–2015 period. The result showed that the average cost efficiency discovered in Bangladesh banking sector was 88.50%. Average efficiency was lower among state-owned banks than conventional (private) commercial banks and Islamic sharia banks. Based on the analysis results, there was a low technological progress in the banking sector during 2011–2015 period. Furthermore, the result of the study showed that non-performing loans had a significant effect in reducing overall cost efficiency among banks.

![Figure 1](https://example.com/figure1.png)

**Figure 1.** Average of Revenue Development, Net Profit Margin (NPM), and Return on Assets (ROA) of Cement Companies in Indonesia

*Source: Annual Report (Data Processed)*

Figure 1 illustrates the average of revenue development, Net Profit Margin (NPM), and Return on Assets (ROA) in the four companies as the object of study, namely Semen Indonesia, Ltd, Lafarge Holcim Indonesia, Ltd, Indocement Tunggal Prakarsa, Ltd, and Semen Baturaja, Ltd. The data were obtained from the financial statements of these four companies. It can be seen that the growth of revenue in 2014–2016 decreased followed by a decrease in NPM and ROA. In contrast, revenue growth began to increase in 2016–2018 without the increase in net profit margin and return on assets. Net profit margin in 2014–2018 always declined. In 2015, NPM decreased from 14.5% to 9.8%, in 2016 it decreased to 8.5%, in 2017 it decreased very drastically to 2.4%, and in 2018 it continued to decline until 1.6%. It did not only experienced declining NPM, but growth in ROA also decreased similar to NPM. In addition, the ROA in 2014–2018 ROA...
decreased significantly. In 2015, it decreased by 32%, continued in 2016 decreased by 13%, in 2017 decreased by 72%, and in 2018 decreased again by 31%.

This phenomenon shows that although businesses in the cement industry experienced sufficient good revenue growth in 2016–2018, there was not necessarily an equal increase in the growths of NPM and ROA. Hence, it is necessary to conduct an analysis related to the efficiency of cement companies and discover important factors influencing the efficiency of cement companies to be able to run business processes and to maintain the company’s performance.

This study was conducted with the following objectives:

1) Knowing the value of input, output, and environmental variables that were efficient in the cement industry in Indonesia in the 2014–2018 period;
2) Knowing the effect of input, output, and environmental variables on the value of efficiency of companies in the cement industry in Indonesia in 2014–2018 period; and
3) Knowing the comparison of efficiency value in companies engaged in the cement industry in Indonesia using SFA method.

Studies on efficiency have been conducted to measure organizational performance on a scale of one company and certain industry. This study refers to previous studies to determine the variables of organizational efficiency measurement. These variables are raw materials cost, labor cost, total assets, income, return on equity, return on assets, and interest rates. Based on the aforementioned framework, this study aims at testing the following hypotheses:

1) H1(+): Input variable of raw materials cost has a significant positive effect on efficiency;
2) H2(+): Input variable of labor cost has a significant positive effect on efficiency;
3) H3(+): Input variable of the number of assets has a significant positive effect on efficiency;
4) H4(+): Output variable of income has a significant positive effect on efficiency;
5) H5(+): Output variable of return on equity has a significant positive effect on efficiency;
6) H6(+): Output variable of return on assets has a significant positive effect on efficiency; and
7) H7(+): Environmental variable of interest rates had a significant positive effect on efficiency.

METHOD

This study employs quantitative method that made accurate measurements of behavior, knowledge, opinions, or attitudes (Indrawati, 2015). The design of the study was comparative and causal. The implementation time in this study was cross-sectional and time series in which the former is a study conducted over a period of time with many samples based on data from the company’s financial statements, while the later is a study by collecting data in several periods that are processed, analyzed, and then concluded in a study (Sekaran & Bougie, 2018).

The population in this study was all cement companies in Indonesia consisting of 13 cement companies registered as members of the Indonesian Cement Association (ASI). The sampling
The technique used in this study was purposive sampling to determine the sampling by specifying specific characteristics that fit the purpose of study.

The criteria of cement companies in Indonesia as the object of study are as follows:
1) Cement companies have been listed on the Indonesia Stock Exchange and are still operating until now; and
2) Companies that have full available quarterly financial reports in period of 2014–2018 on each of the cement company’s websites.

Based on the aforementioned criteria, those four companies, Semen Indonesia, Ltd, Lafarge Holcim Indonesia, Ltd, Indocement Tunggal Prakarsa, Ltd, Semen Baturaja, Ltd, were suitable to be the objects of study.

RESULT AND DISCUSSION

Variable data consist of three input variables, three output variables, and one environmental variable with Decision Making Unit (DMU) of four units in accordance with the number of samples used to measure efficiency based on financial data in a quarterly period of five years. Therefore, the total data panel in the measurement of efficiency was 80 data.

Table 1. The Comparison of Efficiency Value of Cement Companies in Indonesia for the Period of 2014–2018

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Efficiency Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semen Indonesia, Ltd</td>
<td>0.93609</td>
</tr>
<tr>
<td>Indocement Tunggal Prakasa, Ltd</td>
<td>0.50830</td>
</tr>
<tr>
<td>Solusi Bangun Indonesia, Ltd</td>
<td>0.42200</td>
</tr>
<tr>
<td>Semen Baturaja, Ltd</td>
<td>0.09772</td>
</tr>
</tbody>
</table>

*Sources: Data Processed*

Table 1 above presents that Semen Indonesia, Ltd was a cement company having the highest efficiency level in Indonesia (0.93609), followed by Indocement Tunggal Prakarsa (0.50830), then Lafarge Holcim Indonesia (0.42200), and Semen Baturaja (0.09772).

Table 2. Descriptive Statistics of Efficiency Score of Cement Companies in Indonesia for the Period of 2014–2018

<table>
<thead>
<tr>
<th>Item</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.491028</td>
</tr>
<tr>
<td>Min</td>
<td>0.09772</td>
</tr>
<tr>
<td>Max</td>
<td>0.93609</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.436843</td>
</tr>
</tbody>
</table>

*Source: Data Processed*
Table 2 shows that the maximum efficiency value of cement companies in Indonesia for the period 2014–2018 was 0.93609, so it can be concluded that by allocating input and output variables the cement companies in Indonesia could increase efficiency by 0.44507 (0.93609–0.49102).

Based on data processing of input, output, and environment variables in four cement companies in Indonesia in the period of 2014–2018, the mean, min, max, and skewness of these variables can be known, summarized in Table 3 below. The raw materials cost, labor cost, total assets, income, return on equity, return on assets, and interest rates were the variables used in this study.

<table>
<thead>
<tr>
<th>Item</th>
<th>Input Variables</th>
<th>Output Variables</th>
<th>Environmental Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw Materials Cost (in thousand)</td>
<td>Labor Cost (in thousand)</td>
<td>Total Assets (in thousand)</td>
</tr>
<tr>
<td>Min</td>
<td>14,830,000</td>
<td>2,492,224</td>
<td>2,680,797,243</td>
</tr>
<tr>
<td>Max</td>
<td>1,305,356,203</td>
<td>538,142,209</td>
<td>51,155,890,227</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.71</td>
<td>-0.04</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Source: Financial Report (Data Processed)

The results of processing the input, output, and environmental variables using SFA method shows the estimation of the factors affecting the efficiency of the cement companies as in Table 4 below.

<table>
<thead>
<tr>
<th>Variable Types</th>
<th>Variables</th>
<th>Coefficient</th>
<th>t-value</th>
<th>Significant Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Raw Materials Cost</td>
<td>-0.01166</td>
<td>-14.09365</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Labor Cost</td>
<td>0.12683</td>
<td>3.21531</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Total Assets</td>
<td>0.00192</td>
<td>3.01356</td>
<td>*</td>
</tr>
<tr>
<td>Output</td>
<td>Revenue</td>
<td>15.8347</td>
<td>10.10258</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>Return on Equity</td>
<td>0.05669</td>
<td>1.03586</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Return on Asset</td>
<td>0.00072</td>
<td>0.74305</td>
<td>-</td>
</tr>
<tr>
<td>Environmental</td>
<td>Interest rate</td>
<td>0.14064</td>
<td>2.12363</td>
<td>**</td>
</tr>
</tbody>
</table>

Source: Financial Report (Data Processed)

Information:
* Significant at α = 1% (t: 2.374)
** Significant at α = 5% (t: 1.664)
*** Significant at α = 10% (t: 1.292)
The result of processing efficiency using SFA method shows that the input variable of raw materials cost had a significant negative effect on the efficiency value of cement companies, while the input variables of labor cost and total assets had a significant positive effect on the efficiency value of cement companies. The output variables of income had a significant positive effect on the efficiency value of cement companies, while the output of return on equity and return on assets variable did not have a significant effect on the efficiency value of cement companies. Environmental variable of interest rates had a significant positive effect on the efficiency value of cement companies.

The result of data processing on input variables consisting of raw materials cost, labor cost, and total assets in this study in cement companies in Indonesia shows that the average value of raw materials cost was IDR 287,896,085,000, the average value of labor cost was IDR 211,346,222,000, and the average value of total assets was IDR 23,021,757,439,000. While the result of data processing on the output variables consisting of income, return on equity, and return on assets in this study indicated that the average value of income was IDR 3,476,679,249,000, the average value of return on equity was 6.51 %, the average value of return on assets was 4.90%, and the average value of interest rate was 6.12%.

Based on the regression results using SFA method and t-test to prove the significance of the variables influence, the following hypothesis test results were obtained.

**Table 6. Hypothesis Testing**

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>t-value</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: The raw materials cost had a significant positive effect</td>
<td>-14.09365</td>
<td>Significant Negative</td>
</tr>
<tr>
<td>H2: Labor cost had a significant positive effect</td>
<td>3.21531</td>
<td>Significant Positive</td>
</tr>
<tr>
<td>H3: Total assets has a significant positive effect</td>
<td>3.01356</td>
<td>Significant Positive</td>
</tr>
<tr>
<td>H4: Revenue had a significant positive effect</td>
<td>10.10258</td>
<td>Significant Positive</td>
</tr>
<tr>
<td>H5: Return on equity had a significant positive effect</td>
<td>1.03586</td>
<td>Not Significant</td>
</tr>
<tr>
<td>H6: Return on assets had a significant positive effect</td>
<td>0.74305</td>
<td>Not Significant</td>
</tr>
<tr>
<td>H7: Interest rates had a significant positive effect</td>
<td>2.12363</td>
<td>Significant Positive</td>
</tr>
</tbody>
</table>

*Source: Data Processed*

**CONCLUSION**

Based on the results of data processing of input, output, and environment variables in cement companies in Indonesia for the period of 2014–2018 using Stochastic Frontier Analysis (SFA) method, it can be concluded that the input variable of raw materials cost had a significant negative effect on the efficiency value of cement companies, while the input variables of labor costs and
total assets had a significant positive effect on the efficiency value of cement companies. Variable output of income had a significant positive effect on the efficiency value of cement companies, while the variable output of return on equity and return on assets did not have a significant effect on the efficiency value of cement companies. Environmental variable of interest rates had a significant positive effect on the efficiency value of cement companies. Comparison of the efficiency value of cement companies in Indonesia by using Stochastic Frontier Analysis (SFA) method can be concluded that (1) Semen Indonesia, Ltd had the highest efficiency value of 0.936; (2) Indocement Tunggal Prakarsa, Ltd had the second highest efficiency value of 0.508; (3) Lafarge Holcim, Ltd had the third highest efficiency value of 0.422; and (4) Semen Baturaja, Ltd had the lowest efficiency value of 0.0977.

REFERENCE


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