



EFFICIENCY ANALYSIS OF ESG BANKS BEFORE, DURING, AND AFTER COVID-19 USING DATA ENVELOPMENT ANALYSIS APPROACH

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ABSTRACT

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The increasing awareness of sustainable practices in the banking sector raises the question of whether such practices have been implemented efficiently in the context of responding to crises before, during, and after the COVID-19 pandemic. This study aims to analyze the efficiency level of banks included in the SRI-KEHATI Index before, during, and after the COVID-19 pandemic. This study employs a quantitative approach using Data Envelopment Analysis (DEA). The data were obtained from the annual reports and sustainability reports of the sampled banks. The findings show that in 2019, BRI had not yet achieved optimal efficiency. In 2020, all banks listed in the SRI-KEHATI Index demonstrated efficient performance. However, inefficiency reappeared in 2021 in BRI and NISP. These findings indicate that the efficiency of ESG-oriented banks changed across the pre-pandemic, pandemic, and post-pandemic periods. The inefficiency observed in 2021 suggests that post-pandemic efficiency recovery was not evenly experienced by all banks. This study indicates the need to strengthen ESG practices alongside efficient resource management. The findings may provide insights for banks and policymakers in promoting more efficient sustainable banking practices.

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1. INTRODUCTION

Environmental issues have, over time, continued to increase openness toward the importance of environmental sustainability. Various stakeholders have consistently encouraged and pursued efforts to reduce the adverse impacts arising from these issues. This trend has been reinforced by the growing public understanding of sustainability concepts, including corporate standards in implementing operational practices based on environmental, social, and governance principles. Sustainability concerns, particularly those related to the natural environment and its surroundings, have been responded to positively by various industries in Indonesia. The growing encouragement for both society and companies to pay greater attention to environmental issues reflects the increasing relevance of ESG principles in business practices. This shift indicates that business objectives are no longer solely focused on profit generation, but also on creating long-term value through sustainable practices. In the banking sector, sustainability practices may include the distribution of green credit, the allocation of corporate social and environmental responsibility funds, and other responsible financing initiatives.

The issue became even more relevant during the COVID-19 pandemic, when banks were expected to maintain financial stability while also contributing to broader social and environmental resilience. Although previous studies have examined ESG performance and banking efficiency separately, limited research has integrated these two perspectives by analyzing the efficiency of ESG-oriented banks. Few studies have focused on banks listed in the SRI-KEHATI Index and examined their efficiency before, during, and after the peak of the COVID-19 pandemic. This study fills this gap by applying an input-oriented Variable Returns to Scale Data Envelopment Analysis model to assess the relative efficiency of ESG-oriented banks in Indonesia during the 2019–2021 period. Meanwhile, DEA-based banking efficiency studies generally examine efficiency based on bank type, size, ownership, competition, or comparisons between conventional and Islamic banks, with limited attention to ESG-oriented banks, particularly those included in the SRI-KEHATI Index in Indonesia (Hendrawan & Suryanto, 2019); (Sari et al., 2022). Moreover, limited studies have examined whether ESG-oriented banks were able to maintain efficiency during the COVID-19 crisis and in the early recovery period. Therefore, this study addresses this gap by analyzing the relative efficiency of ESG-oriented banks in Indonesia using Data Envelopment Analysis across the pre-pandemic, pandemic, and early recovery periods.

The selection of ESG-oriented banks is relevant because the banking sector plays a strategic role in allocating financial resources toward sustainable economic activities. Banks included in the SRI-KEHATI Index represent institutions with stronger attention to sustainability, social responsibility, and governance principles. Therefore, examining their efficiency is important to assess whether sustainability orientation is supported by efficient resource management. The COVID-19 pandemic provides an appropriate context because it tested the resilience of banks in maintaining stability, supporting economic recovery, and preserving public trust. By comparing efficiency before, during, and after the pandemic peak, this study can identify whether ESG-oriented banks were able to maintain efficient operations under crisis conditions. This focus is also linked to the improvement of financial independence in the public sector. Efficient ESG-oriented banks can support sustainable public financing by channeling resources to priority sectors such as green infrastructure, public services, MSMEs, and recovery programs. In this sense, ESG-oriented banks may strengthen the public sector's access to stable, accountable, and long-term financing, thereby contributing to greater fiscal and financial independence.

It is undeniable that the pandemic triggered a financial crisis across various industries in Indonesia. Slowing and even declining economic growth was one of the major consequences of the COVID-19 pandemic, which lasted for nearly three years. In addition to its financial impact, the COVID-19 pandemic also became a momentum for people around the world to pay greater attention to personal health, including environmental health. Nurhalida & Shofwan (2023) explain that this phenomenon created an awareness that environmental aspects and environmental sustainability are important components in the functioning of the economy and therefore deserve serious attention. Sustainable investing is one activity that considers the Environmental, Social, and Governance aspects, now more commonly referred to as ESG. Corporate practices that incorporate ESG factors have become increasingly popular, particularly in the banking industry, in line with growing demands for ESG implementation within companies (Ng et al., 2020). This development signals the emergence of a renewed approach to investment practices in the financial sector.

In Indonesia, the Indonesia Stock Exchange has demonstrated its support for the sustainability concept by launching the Sustainable and Responsible Investment (SRI)-KEHATI Index in 2009 and by joining the Sustainable Stock Exchanges initiative in 2019. The implementation of ESG is expected to benefit companies by enabling them to expand their markets and reach new market segments, thereby improving corporate profitability (Henisz et al., 2019). Along with this development, several companies from various sectors, including banking, subsequently became constituents of the SRI-KEHATI Index. As of 2023, the banking industry has played a highly vital role in the Indonesian economy, particularly amid the COVID-19 outbreak.

In their study, Nurhalida & Shofwan (2023) explain that companies with a high level of sustainability tend to be more resilient in facing periods of crisis such as COVID-19.

The development of ESG in the financial sector has continued to grow, considering that in contemporary investment activities, investors no longer make decisions solely based on financial factors, but also consider the environmental impact of corporate operations and the commitment to global environmental sustainability (Aditama, 2022). Nevertheless, ESG implementation in Indonesia has not yet been fully optimized. This is partly because only a limited number of companies have been able to adopt sustainability concepts, not all companies are willing to disclose information related to ESG practices, and many firms have not consistently implemented these principles. A similar view is expressed by Kartika et al., (2023), who state that ESG implementation in Indonesia remains in a progressive stage and has not yet been adopted by all companies. Indonesian companies continue to face numerous challenges, including limited corporate understanding of ESG, insufficient resources, and the substantial costs required to implement such practices (International Association for Public Participation Indonesia, 2022).

Siemroth & Hornuf (2023) explain that environmental impact is the most important consideration for investors when making investment decisions, even exceeding factors such as low risk, previous funding received, and others. This issue should therefore receive serious attention from both companies and investors. In making investment decisions, investors should assess the efficiency of ESG implementation within firms. At the same time, companies need to re-evaluate the efficiency of their ESG practices so that the impact of corporate initiatives related to environmental sustainability can be experienced tangibly by all stakeholders. One of the industries strongly encouraged to play an active role in ESG implementation is the banking industry. This industry serves as a vital driver of the economy, given its function as an intermediary institution that bridges surplus units and deficit units (Linarelli et al., 2021). It is also one of the sectors most favored by investors, recording as many as 27.306.567 investment transactions in 2020 (Indonesia Stock Exchange, 2021).

Financial performance in banking refers to banks' ability to manage financial and operational resources to generate optimal outputs, such as loans, net profit, and market value. Beyond profitability, bank performance also reflects the efficiency of intermediation activities, where inputs are transformed into financial and operational outcomes. From an efficiency perspective, Data Envelopment Analysis is relevant because it measures the relative efficiency of Decision-Making Units by considering multiple inputs and outputs simultaneously (Charnes et al., 1978); (Banker et al., 1984). In banking studies, DEA has also been widely used to assess bank efficiency, including in the Indonesian banking context (Sari et al., 2022). ESG banking emphasizes that banks should integrate environmental, social, and governance principles into their operations and financing activities. Prior studies show that ESG practices are associated with banking performance, profitability, firm value, and sustainability-related outcomes (Buallay, 2019); (Alareeni & Hamdan, 2020); (Ng et al., 2020); (Nurhalida & Shofwan, 2023). Therefore, it is important to examine whether ESG-oriented banks can manage their resources efficiently while maintaining strong financial and operational performance.

One important aspect of banking performance evaluation is the ability of banks to maintain their efficiency levels, as this has a strong influence on profitability. Given the growing investor awareness of sustainability-based investment and the role of banking as one of the main pillars of the Indonesian economy, the efficiency of ESG implementation and the resilience of the banking industry are critical issues that must be optimized in order to support Indonesia's national competitiveness (Hendrawan & Suryanto, 2019). To assess the efficiency of ESG implementation in the banking industry, this study employs Data Envelopment Analysis (DEA) by analyzing input and output factors relevant to the research objective. The input factors used in this study are: (1) price of labor, (2) price of funds, (3) price of physical capital, and (4) the realization of corporate social and environmental responsibility funds. The output factors analyzed include: (1) total loans, (2) share price, and (3) net profit. Through this analytical method, the efficiency level of banking

performance in relation to ESG implementation can be identified. DEA is capable of measuring the relative efficiency value of banks and providing guidance on which banks may serve as best practices for others (Syairozi, M. I. et al., 2017). One of the input factors, namely the realization of corporate social and environmental responsibility funds, represents the bank's tangible contribution to social and environmental concerns through the allocation of resources for the development of surrounding communities (Nurhalida & Shofwan, 2023). Such concern for society and the environment is expected to help maintain customer trust in the respective bank, as customer trust is undeniably a fundamental factor in creating effectiveness in the banking sector (Fungáčová et al., 2019).

Based on the preceding discussion, the researcher is interested in examining the efficiency of ESG implementation in banks listed in the SRI-KEHATI Index before the COVID-19 pandemic, during the COVID-19 pandemic, and after the COVID-19 pandemic. Data from 2019 represent the condition of the banking industry before COVID-19 occurred in Indonesia, data from 2020 reflect conditions during the pandemic, marked by the sharp increase in the number of confirmed infections, and data from 2021 represent the post-COVID-19 period, during which the number of infected patients declined and the economy began to recover. The sample of banking companies was identified based on the SRI-KEHATI Index during the 2019-2021 period. The banks included in the sample were PT Bank Central Asia Tbk (BBCA), PT Bank Negara Indonesia (Persero) Tbk (BBNI), PT Bank Rakyat Indonesia (Persero) Tbk (BBRI), PT Bank Tabungan Negara (Persero) Tbk (BBTN), PT Bank Mandiri (Persero) Tbk (BMRI), and PT Bank OCBC NISP Tbk (NISP).

Previous studies on ESG implementation in the banking sector have shown that ESG influences bank profitability (Alareeni & Hamdan, 2020); (Buallay, 2019). Research by Melinda & Wardhani (2020) also indicates that ESG has a positive effect on firm value. With regard to efficiency, earlier studies focusing on the banking sector, such as those conducted by Al-Farisi & Hendrawan (2010); Al-Farisi & Hendrawan (2012); and Wong & Deng (2016) which explained that banking efficiency in Malaysia was better than banking efficiency in other ASEAN countries. Hendrawan & Suryanto (2019) found that banking efficiency in Malaysia was higher than that of banks in other ASEAN countries. Hendrawan & Suryanto (2019) It further reported that rural banks exhibited the highest level of efficiency compared with other types of banks, such as mixed banks, state-owned banks, and national private banks. Although previous studies have provided valuable insights into ESG practices and banking efficiency, they remain limited in several respects. Much of the ESG literature in banking focuses on profitability, firm value, and market-based outcomes, while less attention has been paid to the operational efficiency of ESG-oriented banks. In addition, DEA-based banking efficiency studies have mostly examined efficiency differences across bank types, ownership structures, size classifications, or market competition, rather than focusing on ESG-oriented banks. Existing studies also rarely incorporate sustainability-related resource allocation as part of the input structure in efficiency assessment. Furthermore, limited research has examined the efficiency dynamics of ESG-oriented banks across crisis-related periods, particularly before, during, and after the peak of the COVID-19 pandemic.

In general, efficiency refers to a comparative analysis between a company's inputs and outputs. The primary objective of efficiency is to maximize health levels within the allocated budget (Helwa & Rima, 2024). Efficiency can be achieved when a company is able to produce the same level of output as another company while using fewer inputs. Conversely, efficiency can also be achieved when a company is able to generate a greater level of output using the same amount of input (Riani & Hendrawan, 2020). In previous studies, several researchers have employed efficiency-based approaches, such as Fitriani & Saipudin (2019), who examined the efficiency and effectiveness of village fund budget management, and Fatihah (2020) who investigated the efficiency and effectiveness of regional tax and levy revenues. However, prior studies have not yet examined banking efficiency using the Data Envelopment Analysis method. Banking efficiency is an important indicator for analyzing bank performance and serves as a tool for reviewing the effectiveness of a country's monetary policies, with significant implications for the national economy.

Banks make a significant contribution to economic activity; therefore, banking efficiency is a determining factor in enhancing the effectiveness and resilience of the financial system. There are both internal and external factors that influence banking efficiency. Internal factors consist of the bank's business activities, whereas external factors include competition, market structure, and economic conditions (Sari et al., 2022). Overall, banking efficiency is an important aspect to consider in achieving sound and sustainable financial performance (Marsondang et al., 2019).

A study conducted Fathony (2013) analyzed the efficiency of national banks based on bank size using Data Envelopment Analysis during the 2008–2009 period. The findings showed that large banks were more efficient than medium-sized and small banks. Larger banks had lower average costs per unit as the volume of loans increased. A study by Sari et al., (2022) examined the efficiency of commercial banks in Indonesia for the 2010–2019 period and specifically analyzed competition in the Indonesian banking industry as a factor affecting efficiency. The results showed that competition in the Indonesian banking industry was monopolistic in nature and that competition within the industry had a negative effect on banking efficiency. The study also analyzed other factors that may affect bank efficiency, including Non-Performing Loans (NPL), Loan to Deposit Ratio (LDR), Capital Adequacy Ratio (CAR), bank size, and economic growth. A study conducted by Abidin et al., (2021) analyzed the efficiency of the financial performance of Rural Banks and Islamic Rural Banks in Indonesia using Data Envelopment Analysis. The results indicated that both types of institutions were still inefficient in their intermediation role but efficient in production. Rural Banks operating in urban areas tended to have higher levels of efficiency than those located in regional areas. In addition, the higher the capital level, the more efficient both Islamic and conventional rural banks were in terms of production and intermediation (Hendrawan & Suryanto, 2019). Riani & Maulani (2019) analyzed the determinants of banking efficiency for commercial banks in Indonesia during the 2015–2019 period using Two-Stage Data Envelopment Analysis. The results showed that during the 2015–2019 period, BNI and BCA exhibited inefficiency in managing their resources. In addition, the most significant factors affecting banking efficiency were operating costs and operating income, return on equity, return on assets, and non-performing loans.

Hendrawan & Suryanto (2019) analyzed the efficiency of 85 banks in Indonesia using *Data Envelopment* analyzed the efficiency of 85 banks in Indonesia using Data Envelopment Analysis for the 2008–2017 period. In this study, Indonesian banks were classified into foreign banks, mixed banks, rural banks, and national banks. The findings showed that during the 2008–2017 period, Rural Banks were the most efficient type of bank compared with the other categories. Syaputra & Abidin (2022) analyzed the efficiency of Regional Development Banks in Indonesia during the 2019–2020 period using Data Envelopment Analysis. The results indicated that most Regional Development Banks in Indonesia were still inefficient in carrying out their operational activities. This suggests that the operational costs of Regional Development Banks remained relatively high. Muarief (2019) analyzed the efficiency of commercial banks in Indonesia using Data Envelopment Analysis for five banks, namely Bank Mandiri, BRI, BNI, BCA, and BTN, during the 2009–2013 period. The findings showed that the efficiency levels of these five banks were relatively high, indicating that banking performance was fairly strong in extending credit and generating income.

Based on the background outlined above, this study aims to evaluate the efficiency of ESG-oriented banks included in the SRI-KEHATI Index in Indonesia across three periods: before, during, and after the COVID-19 pandemic. Specifically, this study seeks to examine the efficiency level of ESG-oriented banks prior to the pandemic, assess their efficiency during the COVID-19 period, and analyze how their efficiency changed in the post-pandemic period.

2. RESEARCH METHODS

This study was conducted through several methodological stages. First, the sample was determined by identifying banking companies listed in the SRI-KEHATI Index during the observation period of 2019-2021. Second, secondary data were collected from banks' annual reports,

sustainability reports, financial statements, and stock price data. Third, the input and output variables were selected based on their relevance to banking efficiency and ESG-oriented activities. Fourth, the data were processed using an input-oriented Variable Returns to Scale Data Envelopment Analysis model. Finally, the efficiency scores were interpreted by comparing each bank with the relative efficiency frontier formed by the observed Decision-Making Units.

The reliability of the secondary data was ensured through several procedures. The financial data used in this study were obtained from publicly available annual reports and financial statements published by each bank, while sustainability-related data were obtained from sustainability reports. These reports are official corporate documents and are generally subject to internal control, external audit, and regulatory disclosure requirements. To improve data reliability, the figures used in this study were cross-checked across related reporting sections, such as income statements, balance sheets, notes to financial statements, and sustainability disclosures. In cases where the data were presented in different format across banks, the variables were standardized using the same measurement formula to ensure comparability among Decision-Making Units.

In essence, efficiency is a concept that reflects the ability of a unit to maximize its resources. According to Rambe & Syahputra (2017), efficiency is the comparison or ratio between output and input. Efficiency refers to how well resources are utilized to generate output. More specifically, efficiency can be understood as a “measure” that compares the planned use of inputs with their actual utilization. One method that can be used to measure efficiency is the frontier approach (Israwan et al., 2016). This approach consists of two types, first approach is parametric frontier approach, which is an approach whose model establishes certain assumptions regarding the population parameters underlying the study. The parametric frontier approach can be measured statistically using the Stochastic Frontier Analysis (SFA) method and the Distribution Free Analysis (DFA) method. Second, non-parametric frontier approach, which is an approach that does not impose specific assumptions on the population parameters of the research sample. The non-parametric frontier approach can be measured using the Data Envelopment Analysis (DEA) method, with the following simple formula:

$$Efficiency = \frac{Output}{Input} \dots\dots\dots(1)$$

In practice, this efficient condition may not always be achieved because many factors influence it. Therefore, from a mathematical perspective, efficiency can be approached as a relative measure. In this context, the efficiency value of an object is not compared with an ideal condition of 100 percent, but rather with the efficiency values of other objects. Theoretically, there are several methods for measuring efficiency levels, such as the accounting approach through ratio analysis and the productivity approach through production functions. However, according to Golany & Roll (1989), these methods have several limitations, particularly in the process of quantifying qualitative inputs or outputs, which makes it difficult to determine appropriate weights for each factor used. This argument therefore underlies the need to measure efficiency using the Data Envelopment Analysis (DEA) approach.

Data Envelopment Analysis (DEA) is a non-parametric method used to analyze the efficiency of Decision-Making Units (DMUs). In assessing the efficiency of a DMU, the DEA method uses multiple inputs and outputs to determine an efficiency score (Sari et al., 2022). The relative efficiency of a DMU is measured by calculating the weights of outputs and inputs and then comparing them with those of other DMUs. The results of DEA measurement classify DMUs as either efficient or inefficient, such that efficient DMUs serve as benchmarks for improvement for those that are not yet efficient (Abdullah et al., 2020).

The principles of DEA were originally developed extensively by Charnes, Cooper, and Rhodes in 1978. In theory, DEA calculates the technical efficiency of all units under evaluation. The efficiency score for each unit is relative, depending on the efficiency levels of the other units within the sample. Each unit in the sample is assumed to have a non-negative efficiency level, with values ranging from 0 to 1, where 1 indicates perfect efficiency. Units that obtain a value of 1 are then used

to construct the efficiency frontier, while the other units located below the frontier indicate levels of inefficiency. Based on this concept, Data Envelopment Analysis (DEA) may also be referred to as frontier analysis, or optimal production boundary analysis, which is a performance measurement technique based on linear programming used to evaluate the relative efficiency of Decision-Making Units (DMUs), which may take the form of individuals, organizations, groups, firms, and others. As presented earlier, the basic measure of efficiency used in DEA is the ratio of total output to total input.

There are two DEA analytical approaches that can be applied, namely input-oriented DEA and output-oriented DEA. The objective of input-oriented DEA is to minimize inputs under the assumption of constant output, whereas the objective of output-oriented DEA is to maximize outputs under the assumption of constant input (Abdullah et al., 2020). In this study, an input-oriented approach is employed in order to assess whether there is a possibility for DMUs to reduce their inputs while maintaining the same level of output, thereby improving efficiency and supporting sustainability aspects.

Efficiency measurement using DEA is divided into two models, namely Constant Returns to Scale and Variable Returns to Scale. The Constant Returns to Scale model was the first DEA model introduced by Charnes, Cooper, and Rhodes in 1978. This model assumes a proportional relationship between increases in input and output. If input increases by one unit, output is also expected to increase by one unit. In 1984, this Constant Returns to Scale model was further developed by Banker, Charnes, and Cooper into what is known as the Variable Returns to Scale model. This model assumes that the ratio of increase between input and output is not necessarily equal. If input increases by one unit, output may not increase by one unit, but may instead increase by less than or more than one unit (Abdullah et al., 2020).

In the DEA mathematical formulation, the symbols x and y may be used to represent inputs and outputs, while i and j denote specific inputs and outputs. Thus, x_i represents the i -th input and y_j represents the j -th output of a Decision-Making Unit (DMU). The total number of inputs is denoted by I , and the total number of outputs is denoted by J , where $I, J > 0$. Furthermore, this can be mathematically expressed as follows:

$$\text{Virtual Input} = \sum_{i=1}^I u_i x_i \dots\dots\dots (2)$$

where u_i is the weight assigned to input x_i during the aggregation process. Meanwhile, the output side can be expressed as follows:

$$\text{Virtual Output} = \sum_{j=1}^J v_j y_j \dots\dots\dots (3)$$

Accordingly, v_j may be defined as the weight assigned to output y_j during the aggregation process, and ultimately, based on the virtual input and output model, efficiency can be defined as follows:

$$\text{Efficiency} = \frac{\text{Virtual Output}}{\text{Virtual Input}} = \frac{\sum_{j=1}^J v_j y_j}{\sum_{i=1}^I u_i x_i} \dots\dots\dots (4)$$

The variables, based on the approach of Altunbas et al., (2001) to measure banking efficiency in Germany using the asset approach, are on Table 1. Price of labour is used because personnel expenses represent a controllable operational input in banking activities. Dividing personnel expenses by total assets makes the measure comparable across banks with different asset sizes, so labour cost can be assessed relative to the scale of resources managed by each bank. This approach follows Altunbas et al., (2001), who use price of labour as one of the input prices in bank efficiency analysis. Price of funds represents a fundamental input in banking intermediation because banks rely on deposits and other financial resources to generate earning assets, particularly loans. Measuring interest expenses relative to total funds enables the analysis to capture how efficiently banks acquire and manage their funding sources across different institutional scales (Altunbas et al., 2001). Price of physical capital reflects the operational resources required to support banking

activities, including fixed assets, infrastructure, technology systems, and other supporting facilities. Measuring this cost relative to fixed assets enables the analysis to assess whether banks utilize their physical and operational capital efficiently in generating financial outputs (Bos, 2006). The realization of TJSL is treated as an ESG-related input because it represents the bank’s financial allocation to social and environmental responsibility activities. This inclusion is relevant because CSR spending has been shown to be positively associated with bank efficiency and can support intermediation processes, financial outcomes, reputation, and stakeholder trust (Barman, 2025); (Huang et al., 2022).

Total loan and net profit are selected as output variables because they represent two complementary dimensions of bank performance: intermediation output and financial outcome. Total loans capture the bank’s core role in transforming collected funds into credit, while net profit reflects the final economic value generated from operational and financial activities. This selection is consistent with DEA-based efficiency reasoning, where efficiency is assessed by comparing the ability of decision-making units to generate outputs from given inputs (Iazzolino et al., 2023); (Octrina & Hanif, 2024).

Table 1. Variables based on Altunbas et al., (2001)

Variable	Definition
Input	
Price of Labour (USD mil)	Total personnel expenses divided by total asset
P2 (Price of funds) (%)	Total interest expenses divided by total funds
P3 (Price of physical capital) (%)	Total depreciation and other capital expenses divided by total fixed assets
Output	
Q1 (Mortgage loan) (USD mil)	The dollar value of total aggregate mortgage loans
Q2 (Public loan)	The dollar value of total aggregate public loans
Q3 (Other loan)	The dollar value of total aggregate other loans
Q4 (Securities)	The dollar value of total aggregate securities

Source: Altunbas et al., (2001)

Meanwhile, based on the data available in the financial statements across the three observation periods (2019, 2020, and 2021) for each bank listed in the SRI-KEHATI Index, the variables that can feasibly be used in this study are on Table 2.

Table 2. Variable Used

Variable	Definition	Source
Input		
Price of Labour(%)	Personnel expenses divided by total assets	Bank income statements and balance sheets
Price of Funds (%)	Interest expense divided by total funding	Bank income statements and balance sheets
Price of Physical Capital (%)	Other expenses divided by total assets	Bank income statements and balance sheets
Realization of TJSL (IDR Billion)	Realization of Social and Environmental Responsibility	Bank income statements and balance sheets
Output		
Total Loan (IDR Trillion)	Total loans disbursed by the bank	Balance sheet
Share Price (Rp)	Share price at the end of the final day of the observation year	Yahoo Finance
Net Profit (IDR Trillion)	Bank Net Profit	Balance sheet

Source: data processed, (2025)

The use of DEA in this study is consistent with the literature, which emphasizes that DEA is an appropriate non-parametric method for measuring the relative efficiency of various DMUs involving multiple inputs and outputs. DEA also enables the classification of DMUs into efficient

and inefficient units, allowing efficient DMUs to serve as benchmarks for improvement. The selection of an input-oriented approach is also supported by the literature, as this approach focuses on minimizing inputs while maintaining the same level of output, thereby identifying potential reductions in resource use without decreasing performance. Similarly, the use of the Variable Returns to Scale (VRS) model can be justified because the literature suggests that this model is relevant when changes in inputs and outputs are not proportional and when firms do not operate at an optimal scale. In addition, the use of the non-parametric frontier approach in DEA is supported by the argument that accounting ratio methods and production function approaches have limitations in quantifying qualitative inputs and outputs. Therefore, DEA is considered a more appropriate tool for measuring relative efficiency across units. The selection of variables in this study determines whether the resulting efficiency scores are relevant to the observed banking conditions. However, these selected variables are not the only possible indicators representing banking behavior, particularly among banks included in the SRI-KEHATI Index. One limitation of this study is related to data availability, which required the use of employee expenses as a proxy instead of the number of employees. This may obscure the distinction between the quantity of inputs and outputs and their prices (Ouenniche & Carrales, 2018);(Satrio & Wijaya, 2017). Nevertheless, given these limitations, the interpretation of the findings is conducted cautiously to reduce the sensitivity of the results to the efficiency specification applied to the research objects.

In more detail, the input-oriented VRS model based on Zhu (2014) can be written as follows:

$$\theta^* = \min \theta \dots\dots\dots (5)$$

subject to

$$\sum_{j=1}^n \lambda_j x_{ij} \leq \theta x_{io} \quad i = 1, 2, \dots, m; \dots\dots\dots (6)$$

$$\sum_{j=1}^n \lambda_j x_{rj} \geq \theta y_{ro} \quad r = 1, 2, \dots, s; \dots\dots\dots (7)$$

$$\sum_{j=1}^n \lambda_j = 1 \quad i = 1, 2, \dots, n; \dots\dots\dots (8)$$

Description :

- j : the j -th DMU
- x : input
- y : output
- i : the i -th input of the DMU
- r : the r -th output of the DMU

3. RESULTS AND DISCUSSION

3.1 RESULT

Based on Table 3 shown, the descriptive statistics of the research data reveal that across 18 bank-year observations from 2019 to 2021, the input variables consist of the Price of Labour, Price of Funds, and Price of Physical Capital with averages of 1.29%, 2.92%, and 13.42 respectively, while the fourth input, Realization of TJSL, averages IDR 114.89 billion. On the output side, Total Loan averages IDR 561.17 trillion, Share Price averages 4,035.14, and Net Profit averages IDR 16.11 trillion. The data also shows considerable variability, particularly in Share Price (std. dev. 2,413.81) and Total Loan (std. dev. 314.21), indicating significant differences in scale and performance across the six banks observed during the pre-, during-, and post-Covid-19 periods.

Based on Table 4 shown, the results of the banking efficiency analysis using the DEA method for 2019 (pre-Covid-19 period) indicate that five out of six banks, namely BCA, BTN, Bank Mandiri, BNI, and NISP, achieved perfect efficiency scores of 1.00, demonstrating that these banks were able to optimally utilize their inputs to generate maximum outputs. In contrast, BRI recorded an efficiency score of 0.73, making it the only inefficient bank in this period, suggesting that BRI still had room to improve its resource allocation, particularly given its relatively high Price of Funds (3.77) and Price of Physical Capital (17.04) compared to its peers.

Bank Mandiri had the highest lambda value of 0.82, indicating its significant role as a reference or benchmark unit in the DEA model for this period.

Table 3. Descriptive Statistics

Bank	Price of Labour	Price of Funds	Price of Physical Capital	Realization of TJSL	Total Loan	Share Price	Net Profit
BBCA2019	1.45	1.88	15.78	123	572	6,685	28.57
BBCA2020	1.24	1.32	16.61	117	548	6,770	27.15
BBCA2021	1.10	0.97	15.00	137	590	7,300	31.44
BBRI 2019	1.71	3.77	17.04	227	839	4,400	34.41
BBRI 2020	2.06	3.29	30.65	264	877	4,170	18.66
BBRI 2021	2.27	2.29	30.44	270	910	4,110	30.76
BTN 2019	0.92	5.47	5.67	7	256	2,120	0.21
BTN 2020	0.82	4.53	4.91	18	260	1,725	1.60
BTN 2021	1.02	3.48	16.23	47	275	1,730	2.38
BMRI 2019	1.22	2.85	11.51	162	944	3,838	28.46
BMRI 2020	1.28	2.63	12.34	141	942	3,163	18.40
BMRI 2021	1.31	1.75	14.13	132	1,026	3,513	30.55
BBNI 2019	1.20	3.45	10.63	143	557	7,850	15.51
BBNI 2020	1.09	2.73	11.63	175	586	6,175	3.32
BBNI 2021	1.16	1.57	9.77	93	582	6,750	10.98
NISP 2019	1.23	5.13	7.03	3	114	845	2.94
NISP 2020	1.12	3.17	6.27	4	110	820	2.10
NISP 2021	1.09	2.23	5.88	3	113	670	2.52
AVERAGE	1.29	2.92	13.42	114.89	561.17	4,035.14	16.11
STD-DEV	0.37	1.26	7.42	87.62	314.21	2413.81	12.90
MIN	0.82	0.97	4.91	2.89	109.74	670.00	0.21
MAX	2.27	5.47	30.65	270.46	1,026.22	7,850.00	34.41

Source: Processed data (2025)

Table 4. Results of the Banking Efficiency Analysis for 2019

DMU	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3	Lambda	Efficiency Score
	Price Of Labour (%)	Price Of Funds	Price of Physical Capital	Realization of TJSL (IDR Billion)	Total Loan (IDR Trillion)	Share Price	Net Profit (Rp T)		
BCA	1.45	1.88	15.78	123.49	572	6.685	28.6	0.13	1.00
BRI	1.71	3.77	17.04	226.58	839	4.400	34.4	0.00	0.73
BTN	0.92	5.47	5.67	6.94	256	2.120	0.2	0.00	1.00
Mandiri	1.22	2.85	11.51	162.38	944	3.838	28.5	0.82	1.00
BNI	1.21	3.45	10.63	143.23	557	7.850	15.5	0.05	1.00
NISP	1.23	5.13	7.03	3.21	114	845	2.9	0.00	1.00

Source: Processed data (2025)

Based on Table 5 shown, the results of the banking efficiency analysis using the DEA method for 2020 (during Covid-19 period) reveal that all six banks, namely BCA, BRI, BTN, Bank Mandiri, BNI, and NISP, achieved perfect efficiency scores of 1.00, indicating that each bank was able to maintain optimal operational efficiency despite the economic pressures brought on by the pandemic. Notably, NISP recorded a lambda value of 1, identifying it as a self-referencing efficient unit within the DEA model, while all other banks had a lambda of 0. This finding suggests that the Covid-19 pandemic did not necessarily disrupt banking efficiency, and may have even prompted banks to tighten cost management and resource utilization strategies across all input and output dimensions.

Table 5. Results of the Banking Efficiency Analysis for 2020

DMU	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3	Lambda	Efficiency Score
	Price Of Labour (Percent)	Price Of Funds	Price of Physical Capital	Realization TJSL (IDR Billion)	Total Loan (Rp T)	Price Share	Net Profit (Rp T)		
BCA	1.24	1.32	16.61	117	548	6.770	27	0	1.00
BRI	2.06	3.29	30.65	264	877	4.170	19	0	1.00
BTN	0.82	4.53	4.91	18	260	1.725	2	0	1.00
Mandiri	1.28	2.63	12.35	141	942	3.163	18	0	1.00
BNI	1.09	2.73	11.63	175	586	6.175	3	0	1.00
NISP	1.12	3.17	6.27	4	110	820	2	1	1.00

Source: Processed data (2025)

Based on Table 6 shown, the results of the banking efficiency analysis using the DEA method for 2021 (post-Covid-19 period) indicate that four out of six banks, namely BCA, BTN, Bank Mandiri, and BNI, maintained perfect efficiency scores of 1.00, reflecting sustained optimal performance in the recovery phase. However, BRI experienced a decline in efficiency with a score of 0.67, the lowest across all three observed years, which may be attributed to its high Price of Physical Capital (30.44) and Price of Labour (2.27) relative to its outputs. NISP also showed a near-perfect but slightly inefficient score of 0.99, with a lambda value of 1 indicating its role as a self-referencing unit, suggesting that while most banks adapted well to the post-pandemic environment, BRI faced the greatest challenge in maintaining efficient resource utilization during this recovery period.

Table 6. Results of the Banking Efficiency Analysis for 2021

DMU	Input 1	Input 2	Input 3	Input 4	Output 1	Output 2	Output 3	Lambda	Efficiency Score
	Price Of Labour (Percent)	Price Of Funds	Price of Physical Capital	Realization TJSL (Rp BillionP)	Total Loan (Rp T)	Price Share	Net Profit (Rp T)		
BCA	1.10	0.965	15.005	137	590	7.300	31	0	1.00
BRI	2.27	2.292	30.44	270	910	4.110	31	0	0.67
BTN	1.02	3.476	16.228	47	275	1.730	2	0	1.00
Mandiri	1.31	1.747	14.128	132	1.026	3.513	31	0	1.00
BNI	1.16	1.565	9.767	93	582	6.750	11	0	1.00
NISP	1.09	2.229	5.881	3	113	670	3	1	0.99

Source: Processed data (2025)

3.2 DISCUSSION

From table 3, it can be seen that the inputs used in this study include the price of labour, price of funds, price of physical capital, and the realization of corporate social and environmental responsibility funds. For the price of labour input, the average from 2019 to 2020 across all ESG banks was 1.29%, with a standard deviation of 0.37%, a minimum value of 0.82%, and a maximum value of 2.27%. For the price of funds input, the average from 2019 to 2020 across all ESG banks was 2.92%, with a standard deviation of 1.26%, a minimum value of 0.97%, and a maximum value of 5.47%. For the price of physical capital input, the average from 2019 to 2020 across all ESG banks was 13.42%, with a standard deviation of 7.42%, a minimum value of 4.91%, and a maximum value of 30.65%. For the realization of corporate social and

environmental responsibility funds input, the average from 2019 to 2020 across all ESG banks was IDR 114.89 billion, with a standard deviation of IDR 87.62 billion, a minimum value of IDR 2.89 billion, and a maximum value of IDR 270.46 billion.

The outputs used in this study include total loans, share price, and net profit. For the total loans output, the average from 2019 to 2020 across all ESG banks was IDR 561.17 trillion, with a standard deviation of IDR 314.21 trillion, a minimum value of IDR 109.74 trillion, and a maximum value of IDR 1,026.22 trillion. For the share price output, the average from 2019 to 2020 across all ESG banks was IDR 4,035.14, with a standard deviation of IDR 2,413.81, a minimum value of IDR 670, and a maximum value of IDR 7,850. Share price is used because differences in share prices reflect investment returns or rates of return (Harsanico & Sugiyanto, 2023). For the net profit output, the average from 2019 to 2020 across all ESG banks was IDR 16.11 trillion, with a standard deviation of IDR 12.90 trillion, a minimum value of IDR 0.21 trillion, and a maximum value of IDR 34.41 trillion.

Based on table 4, in 2019, the observed conditions indicate that the efficiency scores of banks included in the SRI-KEHATI Index were, for the most part, already at an optimal level. This can be seen in the efficiency score table, which shows a value of 1 for BCA, BTN, Mandiri, BNI, and NISP. A value of 1 in this column indicates that, given the existing input conditions, the bank was operating optimally in generating its outputs, or in other words, there was no inefficiency in its process. In contrast, a different condition can be observed for BRI's efficiency score in 2019. The table shows that BRI had an efficiency score of 0.73, or 73 percent. This indicates that there was still approximately 27 percent inefficiency that could be optimized.

This study employs an input-oriented DEA approach. Therefore, such optimization can be reflected in the input conditions. For input 1, namely the price of labour, the value of 1.71 percent could still be reduced to 1.24 percent in order to become efficient. For input 2, namely the price of funds, inefficiency is also evident, as the price of funds could be reduced from 3.77 percent to 2.75 percent. Likewise, the price of physical capital could still be optimized by reducing it from 17.04 percent to 12.44 percent. Furthermore, the efficiency process could also be improved through the realization of corporate social and environmental responsibility funds, which could be reduced from IDR 226.58 billion to IDR 165.47 billion.

Based on table 5, in 2020, the observed conditions indicate that the efficiency scores of all banks included in the SRI-KEHATI Index were already at an optimal level. This can be seen from the efficiency scores, which show a value of 1 for all banks. A value of 1 in the efficiency score column indicates that all inputs, consisting of the price of labour, price of funds, price of physical capital, and the realization of corporate social and environmental responsibility funds, were allocated efficiently, thereby producing an optimal combination of outputs. This condition of 100 percent efficiency is particularly interesting, given that 2020 was the first year of the COVID-19 pandemic, yet the performance of ESG banks appeared to remain relatively positive. This condition may be attributed to the high level of uncertainty during the pandemic, which led companies to operate with greater caution.

Entering 2021, the observed conditions became more varied. Based on table 6, it can be seen from the efficiency scores, where the maximum efficiency value of 1 was achieved only by several banks, namely BCA, BTN, Mandiri, and BNI. Meanwhile, BRI recorded an efficiency score of only 67 percent. This indicates that in 2021, BRI still had 33 percent of its inputs that could be made more efficient. More specifically, this could be achieved by reducing the price of labour from 2.27 percent to 1.52 percent. In addition, BRI still had room to improve efficiency in the price of funds input by reducing it from 2.29 percent to 1.53 percent. For the third input, namely the price of physical capital, BRI also had the opportunity to improve efficiency by reducing it from 30.44 percent to 20.42 percent. Furthermore, for the fourth input, namely corporate social and environmental responsibility funds, efficiency could be improved by reducing the realized amount from IDR 270 billion to IDR 181.48 billion.

Meanwhile, NISP in 2021 also showed a condition that had not yet reached the optimal efficiency level. This can be seen from its efficiency score, which had not yet reached 1 but stood at 0.99, or 99 percent. This indicates that there was still 1 percent inefficiency that could be optimized in order for NISP to operate efficiently at that output level. This could be achieved by reducing the realization of corporate social and environmental responsibility funds from IDR 3 billion to IDR 2.89 billion. The findings of this study are partly consistent with previous research showing that ESG practices are associated with better financial performance, profitability, firm value, and resilience (Buallay, 2019); (Alareeni & Hamdan, 2020); (Melinda & Wardhani, 2020); (Nurhalida & Shofwan, 2023). The full efficiency of all observed ESG-oriented banks in 2020 supports the view that sustainability-oriented banks may be more capable of maintaining performance during crisis conditions. However, the inefficiency of BRI in 2019 and 2021, as well as NISP in 2021, indicates that ESG orientation does not automatically lead to efficiency. This finding adds a more critical perspective to previous ESG-performance studies by showing that sustainability commitment must be accompanied by efficient input management. Compared with prior DEA-based banking studies that mainly examined efficiency based on bank type, size, ownership, competition, or conventional-Islamic bank comparisons Hendrawan & Suryanto (2019); Abidin et al., (2021); Sari et al., (2022), this study extends the literature by applying DEA specifically to ESG-oriented banks listed in the SRI-KEHATI Index and by including social-environmental responsibility expenditure as an ESG-related input.

4. CONCLUSION

Based on the results of the study, it can be concluded that corporate activities, particularly in the banking sector, that integrate sustainability principles, environmental, social, and governance—have a positive impact on business sustainability. One of these benefits is the ability to enhance firm value and improve resilience during critical conditions, such as the COVID-19 pandemic. Nevertheless, the benefits of implementing sustainability practices require a considerable amount of time before they can be fully realized by both companies and surrounding communities. Not all banks in Indonesia have fully implemented ESG principles, as reflected by the fact that only a small number of banks are included in the SRI-KEHATI Index, namely BCA, Mandiri, BNI, BRI, BTN, and NISP. If the SRI-KEHATI Index is observed over time, no bank has been consistently listed in the index in every period. The main contribution of this study is to show that ESG-oriented banking performance can be evaluated not only from profitability, firm value, or sustainability disclosure, but also from the perspective of relative efficiency in managing operational and sustainability-related inputs. Theoretically, this study enriches the literature on banking efficiency by connecting ESG orientation with Data Envelopment Analysis. Practically, the findings provide useful insights for banks, regulators, and policymakers in designing more efficient and sustainable banking strategies.

Based on the data obtained and the analysis of the efficiency values of banks listed in the SRI KEHATI Index during 2019–2021 using the DEA method, the findings of this study show the efficiency condition of ESG-oriented banks listed in the SRI-KEHATI Index in 2019 was, for the most part, already optimal, as indicated by an efficiency value of 1 for BCA, BTN, Mandiri, BNI, and NISP. In contrast, BRI recorded an efficiency score of 0.73, or 73 percent, indicating that there was still 27 percent inefficiency that needed to be optimized by considering the existing input conditions, namely the price of labour, price of funds, price of physical capital, and the realization of corporate social and environmental responsibility funds. This finding implies that banks with efficiency scores below 1 need to conduct a more detailed evaluation of input allocation, particularly in labour costs, funding costs, physical capital, and social-environmental responsibility expenditure

The efficiency condition of ESG-oriented banks listed in the SRI-KEHATI Index in 2020 was entirely efficient. This finding is particularly noteworthy because 2020 was the year when the COVID-19 pandemic intensified and caused a decline in the Indonesian economy, yet all of the banks examined in this study remained efficient. This condition may be attributed to the high level

of uncertainty during the pandemic, which led companies to operate with greater caution in implementing ESG principles. ESG-oriented banks that undertook social and environmental actions during COVID-19 generally incurred higher sustainability-related costs as an effort to obtain legitimacy from the public and stakeholders. This, in turn, may have contributed to greater public trust in conducting financial activities, thereby indirectly supporting the stability of the banking sector. Based on this finding, policymakers and banking regulators should encourage the use of efficiency-based ESG evaluation, so that sustainability programs are not assessed only from the amount of expenditure or disclosure, but also from their contribution to efficient resource use and financial performance. Banks should also link ESG-related spending to measurable performance indicators, such as credit distribution, profitability, service quality, stakeholder trust, and long-term institutional resilience.

The efficiency condition of ESG-oriented banks listed in the SRI-KEHATI Index in 2021 showed more varied results. Maximum efficiency values of 1 were achieved by several banks, namely BCA, BTN, Mandiri, and BNI. Meanwhile, the other two banks, BRI and NISP, had not yet achieved full efficiency, with efficiency scores of 67 percent for BRI and 99 percent for NISP. This indicates that in the post-COVID-19 period, both banks still needed to optimize the input variables examined in this study. Therefore, this study recommends that ESG-oriented banks conduct periodic efficiency assessments, strengthen input cost monitoring, evaluate social and environmental responsibility spending more carefully, and integrate DEA-based indicators into sustainable banking performance evaluation. However, this study is limited to banks listed in the SRI-KEHATI Index during 2019–2021, uses a relatively small number of Decision Making Units, and relies on secondary data from annual reports, sustainability reports, financial statements, and stock price data. In addition, the realization of corporate social and environmental responsibility funds only represents one ESG-related input and does not fully capture the broader quality of ESG implementation. Future research should extend the observation period, include more banks, compare ESG-oriented and non-ESG banks, and incorporate broader ESG indicators or two-stage DEA analysis to provide a more comprehensive understanding of ESG banking efficiency

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