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OPERATIONAL EFFICIENCY ANALYSIS OF REGIONAL DEVELOPMENT BANKS USING DATA ENVELOPMENT ANALYSIS (DEA): A CASE OF STUDY OF BANK SUMUT

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Abstract

This study analyzes the operational efficiency of Bank Sumut over the period 2014–2024 using an input-oriented Data Envelopment Analysis (DEA) approach, based on secondary data from annual financial reports. DEA is selected for its ability to assess the relative efficiency of decision-making units (DMUs) by accounting for multiple inputs and outputs without requiring a specific functional form. Beyond conventional efficiency measurement, the study highlights how optimal resource allocation—such as labor and capital—can enhance the bank's contribution to sustainable development, in line with Indonesia's transition toward a green economy. Key findings include: (1) annual efficiency scores benchmarked against industry standards, (2) identification of inefficiencies in the form of input excesses and output shortfalls, and (3) strategic recommendations to improve operational efficiency and resilience. By linking operational performance with sustainable financing capacity, this research offers a dual contribution: enriching the literature on regional bank efficiency and informing policy discussions on the role of Regional Development Banks (RDBs) in achieving the Sustainable Development Goals (SDGs), particularly in developing countries facing resource constraints.

Keywords: banking efficiency, data envelopment analysis, regional development, Indonesia, sustainable finance

INTRODUCTION

The banking sector plays a vital role in maintaining economic stability and promoting growth through its fund intermediation function (Kasmir, 2018; Dendawijaya, 2015). In this context, operational efficiency becomes a critical factor, particularly for Regional Development Banks (RDBs) such as Bank Sumut, which carry a dual role as commercial institutions and agents of regional development.

In the era of digital transformation and open competition, banking efficiency extends beyond cost reduction to include resource optimization, technological adoption, and service innovation aimed at enhancing financial inclusion (Berger & Humphrey, 2017). These challenges are further intensified by the emergence of digital banks and non-bank financial institutions offering faster and more affordable services (Prasetya & Budiwitjaksono, 2023).

One of the most widely used methods for evaluating banking efficiency is Data Envelopment Analysis (DEA), a non-parametric technique capable of measuring the relative efficiency of decision-making units (DMUs) (Coelli et al., 2005; Emrouznejad & Yang, 2018).

Recent studies underscore the urgency of assessing RDB efficiency. Mariam et al. (2024) identified significant variations in technical efficiency among Indonesian banks, while Fitri et al. (2024) emphasized the importance of efficiency in supporting green banking and sustainable development agendas. Wahyudi and Azizah (2023) reported that the efficiency of Indonesian banks remains relatively low compared to other ASEAN countries. Moreover, Putri et al. (2023) argued that efficiency is a key determinant of RDB effectiveness in supporting regional economic growth.

As a regional bank operating in North Sumatra, Bank Sumut holds a strategic role in financing priority sectors such as infrastructure, agriculture, and micro, small, and medium enterprises (MSMEs). Its efficiency level is influenced by internal factors, including management and technological capacity (Nugraha et al., 2023; Vidianata & Satria, 2022), as well as external factors such as regulatory frameworks and fiscal policy (Grigorian & Manole, 2015; Salma et al., 2022).

Based on this background, the present study aims to measure the operational efficiency of Bank Sumut using the DEA approach and to address the research question: "How efficient is the operational performance

of Bank Sumut as one of the Regional Development Banks in Indonesia based on the DEA approach?" This research is expected to contribute both theoretically and practically, with a particular focus on technical efficiency based on secondary data from Bank Sumut's financial statements.

RESEARCH METHODS

An input-oriented Data Envelopment Analysis (DEA) approach is employed in this study due to its ability to measure the relative efficiency among decision-making units (DMUs) without assuming a specific production function. Moreover, this method is capable of capturing the operational complexity of banks, which typically involve multiple inputs and outputs. This study adopts a descriptive and exploratory design, aiming to measure and analyze the operational efficiency of Bank Sumut over the 2014–2024 period, as well as to identify sources of inefficiency and provide strategic recommendations for performance improvement.

The data used in this research are secondary data obtained from the annual financial reports of Bank Sumut, as well as publications from the Financial Services Authority (OJK) and Bank Indonesia. Each year is treated as a separate DMU, resulting in a total of 11 DMUs for analysis. The input variables include the number of employees, productive assets, and operating expenses. The output variables consist of operating income, total loans disbursed, and net profit. This study applies two DEA approaches—Constant Return to Scale (CRS) and Variable Return to Scale (VRS)—to evaluate both overall technical efficiency and scale efficiency of the bank's operations.

The DEA-CCR formula (Input-Oriented):

Let there be:

- x_{ij} : The i-th input of the j-th DMU (Decision Making Unit),
- y_{rj} : The r-th output of the j-th DMU,
- λ_j : The weight of the j-th DMU,
- x_{io}, y_{ro} : The input and output of the DMU under evaluation (DMUo),
- θ : The efficiency score.

Model Linear Input-Oriented CRS:

$\min \theta_{\theta,\lambda}$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{io} \quad ,\forall i$$
$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq \text{yro}, \quad \forall r$$
$$\lambda_j \geq 0 \ ,\forall j$$

Interpretation:

- θ=1 = 1 θ=1 → The DMU is efficient (lies on production frontier)
- θ<1 < 1 θ<1 → The DMU is inefficient (requires input reduction to achieve efficienty)

Meanwhile, the Variable Return to Scale (VRS) model developed by Banker, Charnes, and Cooper (1984) offers greater flexibility by accommodating conditions in which DMUs may operate under non-optimal scale. The VRS model allows for a distinction between pure technical efficiency and scale efficiency. As such, it provides additional insights into whether inefficiencies stem from internal management factors (technical inefficiency) or from an inappropriate operational scale. In the context of this study, the combination of both models—CRS and VRS—is employed to obtain a more comprehensive understanding of the operational efficiency of Bank Sumut, and to identify potential areas for improvement both in terms of managerial practices and scale structure.

Additional constraint VRS:

$$\sum_{j=1}^{n} \lambda_j = 1$$

This constraint ensures that the linear combination of the reference DMUs forms a convex hull (rather than a straight line), thereby allowing the model to capture both increasing and decreasing returns to scale.

Brief comparison:

Table 1 Comparisons of CRS (CCR) and VRS (BCC) Methods

Aspect	CRS (CCR) Model	VRS (BCC) Model
Scale of operation	Constant	Variable (may increase or decrease)

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Aspect	CRS (CCR) Model	VRS (BCC) Model
Type of efficiency measured	Overall technical efficiency	Pure technical efficiency
Additional constraint	None	$\sum\lambda_j = 1$
When to use	When DMUs are assumed to operate optimally	When DMUs may operate at suboptimal scale

Source: Model BCC (Banker, Charnes, & Cooper (1984)

The conceptual framework of this study is built upon the understanding that a bank's operational efficiency is determined by its ability to optimize the use of inputs to generate maximum outputs. This process is illustrated in a systematic flow, where inputs such as labor, assets, and operating costs are processed through the bank's intermediation function to produce outputs in the form of revenue, credit distribution, and profit. By employing DEA, the study quantitatively maps the relationship between inputs and outputs, and assesses the extent to which each DMU (year) achieves maximum efficiency. The findings are expected to provide strategic recommendations for improving efficiency and highlight the bank's contribution to supporting sustainable regional development.

RESULTS AND DISCUSSIONS

This study employs the Data Envelopment Analysis (DEA) approach using the Constant Return to Scale (CRS) model, also known as the CCR model, to measure the total technical efficiency of Bank Sumut during the period 2014–2024. The CRS model assumes a constant scale of operation, meaning that changes in input result in proportional changes in output.

Table 2 DEA Estimated Results

DMU	VRS		CRS	
	Score	Benchmark (λ)	Score	Benchmark (λ)
2014	1	2014(1)	1	2014(1)
2015	1	2015(1)	1	2015(1)
2016	1	2016(1)	1	2016(1)
2017	1	2017(1)	1	2017(1)
2018	1	2018(1)	1	2018(1)
2019	1	2019(1)	1	2019(1)
2020	0.978452	2014(12%);2016(64%);2024(24%)	0.977271	2014(21%);2016(57%);2024(23%)
2021	0.982254	2016(63%);2024(37%)	0.931979	2016(31%);2019(5%);2024(58%)
2022	0.976239	2016(3%);2017(31%);2024(65%)	0.965347	2016(24%);2017(20%);2024(58%)
2023	1	2023(1)	1	2023(1)
2024	1	2024(1)	1	2024(1)

Source: Data Processing Result, 2025

Based on data processed using MAXDEA, it was found that in eight years within the study period—namely 2014 to 2019, as well as 2023 and 2024—Bank Sumut demonstrated an efficiency score of 1.000, indicating that the bank operated efficiently. In these years, inputs such as the number of employees, operational expenses, and assets were optimally converted into outputs in the form of loans, operating income, and net profit.

However, in 2020, 2021, and 2022, there was a decline in efficiency. The efficiency scores for these years were 0.977, 0.932, and 0.965, respectively. This decline indicates the presence of relative inefficiency in the use of operational resources. Through benchmark analysis (lambda), it was identified that these years referred to a combination of best practices from 2014, 2016, and 2024—years that served as reference DMUs due to their optimal performance.

To further understand whether the inefficiencies found in the CRS model were caused by internal management or by scale of operations, additional analysis was conducted using the Variable Return to Scale (VRS) DEA model, also known as the BCC model. This model does not impose the constant scale assumption and thus can isolate pure technical efficiency from scale effects.
The VRS results showed high efficiency scores for most years. The years 2014–2019 and 2023–2024 maintained a score of 1.000, indicating that the bank was not only efficient overall but also technically pure efficient. Meanwhile, the years 2020–2022 experienced a decline in scores, but these scores remained higher compared to the CRS scores in the same years:

- Year 2020 : VRS score = 0,978

- Year 2021 : VRS score = 0,982
- Year 2022 : VRS score = 0,976

The relatively small difference between the CRS and VRS scores in these years indicates that the main inefficiency does not stem from managerial errors but rather from the mismatch in the scale of operations.

***Scale* Efficiency (SE)** is calculated as the ratio of the CRS score to the VRS score, as follows:

The result:

$$SE = \frac{\text{DEA CRS score}}{\text{DEA VRS score}}$$

Year 2021 recorded the lowest Scale Efficiency (0.949), indicating that the scale of operations was not yet optimal. Meanwhile, years 2020 and 2022 showed SE values close to 1, meaning the efficiency was almost unaffected by scale.

Table 3 Calculation of Scale Efficiency

Year	CRS	VRS	SE	Year	CRS	VRS	SE
2014	1	1	1	2020	0.977	0.978	0.999
2015	1	1	1	2021	0.932	0.982	0.949
2016	1	1	1	2022	0.965	0.976	0.989
2017	1	1	1	2023	1	1	1
2018	1	1	1	2024	1	1	1
2019	1	1	1				

Source: Data Processing Result, 2025

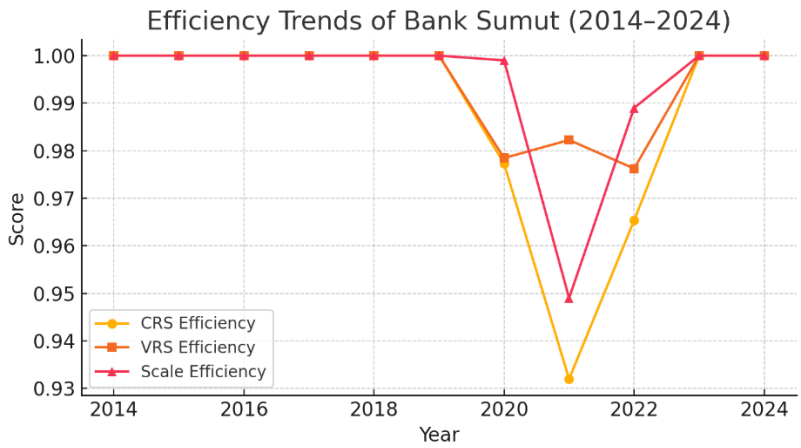

Figure 1
Efficiency Trends of Bank Sumut (2014-2024)

The graph shows that full efficiency was achieved in most years, but a decline occurred during 2020–2022. Recovery is clearly visible in 2023 and 2024.

The efficient years ranked first, while 2021 recorded the lowest rank. This reinforces the previous finding that this year was the weakest point of efficiency during the decade.

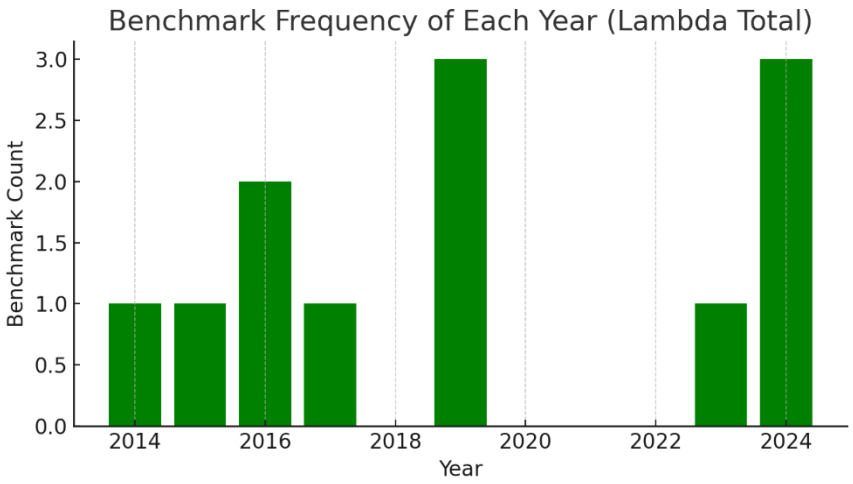

Figure 2
Benchmark Frequency of Each Year (Lambda Total)

The years 2016 and 2024 were the most dominant as benchmarks for inefficient DMUs, indicating that operational practices in these years were highly optimal.

Data Envelopment Analysis (DEA) of Bank Sumut during the 2014–2024 period shows that operational efficiency was consistently achieved in 2014–2019 and 2023–2024, marked by perfect DEA scores (1). This reflects the optimal utilization of resources, including labor, operational expenses, and total assets, in generating loans, income, and net profit. Conversely, a decline in efficiency occurred in 2020–2022, with scores ranging from 0.932 to 0.977. This inefficiency was caused by excess inputs, especially in the number of employees and operational expenses, as well as a shortfall in output related to net profit.

This condition is closely related to the impact of the COVID-19 pandemic, which reduced loan demand, prompted loan restructuring, and narrowed profit margins due to lower interest rates. The sudden shift to digital services also added cost pressures without directly increasing revenue. DEA indicates the need for efficiency improvements by reducing employees by approximately 5% and saving an average of IDR 45 billion in operational expenses annually during the period. Negative Returns to Scale (RTS) values further confirm a mismatch between the scale of operations and market dynamics.

Nevertheless, the recovery of efficiency in 2023–2024 demonstrates Bank Sumut's effective strategic response through organizational restructuring, credit portfolio strengthening, and accelerated digitalization. This reinforces the bank's capacity to support sustainable development agendas. Consistent operational efficiency enables greater resource allocation to productive and inclusive sectors, including green financing, MSMEs, sustainable agriculture, and clean energy.

Thus, efficiency not only plays a role in maintaining profitability but also serves as an important prerequisite for Bank Sumut's contribution to achieving the Sustainable Development Goals (SDGs), especially in the context of transitioning to a green and inclusive economy. Inefficient years serve as important lessons for strengthening operational resilience in the future.

CONCLUSIONS AND SUGGESTIONS

The DEA analysis of Bank Sumut's operational performance during the 2014–2024 period shows that scale inefficiency occurred only in 2020–2022, caused by external factors such as the COVID-19 pandemic, credit restructuring policies, declining benchmark interest rates, and the shift of customer behavior towards digital banking. These factors resulted in underutilization of the bank's assets and reduced profit margins, while operational costs remained high. Outside of this period, particularly in 2014–2019 and 2023–2024, economic stability and the recovery of loan demand supported the return of operational efficiency, indicating that the previous inefficiencies were temporary and not due to managerial weaknesses. These findings contribute to the literature on regional banking efficiency while offering practical perspectives for strengthening the strategic role of Regional Development Banks in sustainable development.

Strategic recommendations include strengthening internal management through business process optimization, digitalization, and human resource reform to improve operational cost efficiency. Additionally, regular evaluation of the scale of operations is necessary, especially when Scale Efficiency (SE) values indicate over-scale or under-scale conditions. The bank also needs to increase the proportion of sustainability-oriented financing, including the MSME sector and the green economy, as a tangible contribution to the sustainable

development agenda. Lastly, developing a periodic data-based efficiency monitoring system is crucial to track operational performance and respond to risks more quickly and effectively.

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