
MEASURING TECHNICAL EFFICIENCY OF INDONESIAN PUBLIC UNIVERSITIES USING DEA: A COMPARATIVE AND LONGITUDINAL APPROACH

Soffan Marsus¹, Mediya², Hendry Wibowo³

¹Politeknik Keuangan Negara STAN, Tangerang Selatan, Indonesia

^{2,3}Direktorat Jenderal Perbendaharaan, Kemenkeu Republik Indonesia

Email: soffanm@kemenkeu.go.id

Abstract

This study investigates the technical efficiency of Indonesian public service universities (PTN-BLU) using Data Envelopment Analysis (DEA), focusing on variations across time and model specifications. The research aims to assess whether institutions that were efficient between 2017 and 2019 maintained their performance through 2023, and how different combinations of input-output variables affect efficiency outcomes. Two DEA models were applied using R programming and were compared with previous results from Sulaeman and Adzillah. The analysis included data on academic, financial, and institutional outputs, covering 48 PTN-BLU. Findings show that only a limited number of universities sustained efficiency over time, suggesting institutional changes or policy impacts. A comparison of the two models revealed substantial differences in efficient unit rankings, demonstrating the sensitivity of DEA results to variable selection. Additionally, slack analysis indicated that improvements are needed in both inputs and outputs for most inefficient institutions. The study concludes that an integrative DEA model offers a more comprehensive understanding of university performance, and recommends further research using standardized data to support long-term efficiency evaluation in higher education.

Keywords: *Technical Efficiency, Data Envelopment Analysis, PTN-BLU, Higher Education, R Programming.*

A. INTRODUCTION

In recent years, evaluating the performance of higher education institutions has become increasingly reliant on quantitative methods, especially in the case of public service universities (Perguruan Tinggi Negeri Badan Layanan Umum, PTN-BLU) in Indonesia. Among the prominent approaches used for efficiency analysis, Data Envelopment Analysis (DEA) stands out for its capability to accommodate multiple inputs and outputs without requiring a predefined production function. As a non-parametric technique rooted in linear programming, DEA constructs an empirical efficiency frontier, allowing for relative comparisons across institutions operating under varying constraints. This analytical flexibility makes DEA particularly well-suited for assessing institutional efficiency in complex and resource-limited academic environments.

The origins of Data Envelopment Analysis (DEA) can be linked to Farrell's (1957) framework, which defines overall economic efficiency as the intersection of technical and allocative performance. While technical efficiency focuses on maximizing output relative to input resources, allocative efficiency addresses the cost-effectiveness of input selection. The BCC model (Banker et al., 1984) further refined this by introducing Variable Returns to Scale (VRS), a feature particularly useful for higher education where institutions vary significantly in size and scope.

In Indonesia, the application of DEA is especially pertinent for State Universities operating as Public Service Agencies (BLU). Governed by Government Regulation No. 23/2005 (later updated by PP No. 73/2012) (Pemerintah Republik Indonesia, 2012), these entities possess the flexibility of private-sector financial management while remaining tied to strict state accountability. This hybrid structure, balancing operational independence with public performance standards, underscores the necessity of robust benchmarking tools like DEA.

This study is a direct extension of a previous work by the same authors, Marsus et al. (2025), which revisited the technical efficiency analysis of PTN-BLU by replicating and expanding upon Nugraha et al. (2019). The earlier study reanalyzed the 2013–2015 dataset using three DEA tools, EMS, MaxDEA, and a newly developed R-based script, and found that software choice significantly affected the resulting efficiency scores.

Discrepancies were particularly evident in the EMS results, raising concerns about tool reliability, data handling, and algorithmic transparency. While the previous research focused primarily on methodological issues, such as tool comparison and the reproducibility of DEA results, it left open several avenues for empirical expansion. In particular, it did not explore how PTN-BLU efficiency evolved over time nor did it consider explanatory factors behind efficiency variation across institutions. Moreover, although DEA provides valuable static efficiency measures, understanding the drivers of performance variation requires combining DEA results with contextual data and exploring institutional characteristics.

To address these gaps, the present study adopts the input-output model used by Sulaeman and Adzillah (2022) and applies the validated R-based DEA script to a new dataset covering 32 PTN-BLU institutions from 2017 to 2019. In doing so, this study shifts the focus from validating tools to interpreting performance trends and identifying patterns across institutions and time. This not only adds to the empirical literature on higher education efficiency in Indonesia but also contributes to the development of evidence-based decision-making in resource allocation and performance monitoring.

The main objective of this study is to assess the technical efficiency of Indonesian PTN-BLU institutions during the 2017–2019 period using an input-oriented Data Envelopment Analysis (DEA) model under Variable Returns to Scale (VRS) assumptions, while simultaneously comparing efficiency scores across years to identify institutions that consistently perform efficiently or inefficiently, and highlighting observable patterns or institutional characteristics that may explain variations in efficiency, thereby providing policy-relevant insights for improving resource utilization and overall institutional performance. By combining methodological rigor with empirical relevance, this study aims to support the ongoing efforts of the Ministry of Education and institutional leaders in fostering a culture of performance accountability, transparency, and continuous improvement in the higher education sector.

B. LITERATURE REVIEW

The literature review critically examines recent and relevant scholarly work related to the research topic. It synthesizes existing theories, empirical findings, and conceptual frameworks to establish a theoretical foundation for the study. This section should identify major debates, key authors, and notable gaps in current knowledge. The goal is not to summarize every piece of related research, but to highlight what has been done and how the current study will contribute something new or different. The review should also identify contradictions, limitations, or underexplored areas that justify the need for the present study. A well-developed literature review ensures that the research is grounded in scholarly context and aligned with academic discourse.

1. Performance Measurement in Higher Education Institutions (HEIs)

Performance measurement in public sector organizations, including Higher Education Institutions (HEIs), has become increasingly important due to demands for accountability, transparency, and resource optimization. HEIs are expected to deliver high-quality education, conduct impactful research, and contribute to society, often within constrained budgets. As a result, several performance assessment frameworks have been adopted globally, ranging from Key Performance Indicators (KPIs) to more comprehensive efficiency-based models such as the Data Envelopment Analysis (DEA).

In the context of Indonesian public universities, especially the Public Service Agency State Universities (PTN-BLU), performance measurement is further mandated by their financial autonomy status. These institutions are required to demonstrate both academic and financial efficiency, making them a suitable object of study for DEA-based efficiency analysis.

2. The Application of DEA in Measuring Efficiency of HEIs

Data Envelopment Analysis (DEA) has been widely used in evaluating the performance of HEIs due to its ability to handle multiple inputs and outputs without requiring predefined weights. DEA's flexibility in modeling efficiency from either input-oriented or output-oriented perspectives makes it especially suitable for HEIs, where educational outputs (graduates, research, publications) are often influenced by diverse and interrelated inputs (faculty, budget, infrastructure).

Past studies have utilized various DEA models. Notably, Johnes (2006), Abbott and Doucouliagos (2003), and Worthington (2001) explored technical efficiency in universities across different countries, often using variations of DEA to compare institutional performance.

3. DEA Studies on Indonesian HEIs

In the Indonesian context, research on HEI efficiency using DEA remains relatively limited but is growing. Nugraha et al. (2018) analyzed technical efficiency in Indonesian public universities using an input-oriented VRS model, focusing on the 2013-2015 period. They identified significant variations in efficiency levels and suggested targeted policy interventions. That study formed the basis for further research using alternative data and software environments.

More recently, Sulaeman and Adzillah (2022) extended this line of inquiry by evaluating the technical efficiency of 32 PTN-BLU using data from 2017 to 2019. They employed a DEA-VRS input-oriented model and incorporated both educational and financial inputs to reflect the dual mandate of PTN-BLU institutions. The study revealed that while some universities consistently operated efficiently, others demonstrated potential inefficiencies, particularly in budget utilization and research outputs.

4. Methodological Developments and Software Tools

Most DEA applications in Indonesian HEIs have relied on proprietary software such as EMS and MaxDEA. However, open-source tools, particularly those developed in R, are gaining traction for their flexibility, reproducibility, and cost-effectiveness. The current study builds upon this methodological expansion by validating efficiency measurements using a custom R script, providing a robust and transparent alternative for institutional benchmarking.

5. Research Gaps and Contributions of the Present Study

While Sulaeman and Adzillah (2022) provide a strong foundation, their analysis can be extended in several directions. First, there is room to deepen the discussion on the input mix used

by PTN-BLU, especially regarding the efficiency of budget allocations relative to research and community service outputs. Second, DEA results can be further contextualized by comparing them across different software platforms, ensuring consistency and robustness. Lastly, integrating more recent data and exploring dynamic efficiency patterns over time could offer richer insights into institutional performance trends.

Therefore, the present study aims to replicate and validate the findings of Sulaeman and Adzillah (2022) by employing alternative software tools, extend the DEA analysis through the use of more refined input–output configurations, and provide policy-relevant insights related to budgeting and performance improvement in higher education institutions.

C. METHOD

This study employs a quantitative descriptive design to evaluate the technical efficiency of Indonesian public universities with Public Service Agency (BLU) status using Data Envelopment Analysis (DEA). The research adopts an input-oriented DEA under Variable Returns to Scale (VRS), which focuses on minimizing input use while maintaining current levels of output. This orientation aligns with public service objectives, where input efficiency is often more relevant than output maximization.

The population consists of all PTN-BLU institutions in Indonesia. The sample includes 16 institutions selected based on data availability across the four observed years. This subset allows for a balanced panel dataset in the integrated model. The 2017–2019 data were obtained from the reconstructed results of Sulaeman and Adzillah (2022), with technical adjustments to conform to an input-oriented DEA model. The 2023 data were sourced from institutional performance and financial reports, compiled by the authors to match the same set of input and output variables.

The DEA model employs three input variables and three output variables, following the adjusted framework proposed by Sulaeman and Adzillah (2022). The input variables consist of the number of students, the number of lecturers, and total expenditure as a proxy for operational costs, while the output variables include the number of graduates, the average GPA (IPK), and non-tax revenue from educational services (PNBP). This configuration is designed to capture both academic productivity and institutional efficiency, while ensuring data consistency and comparability across the four-year observation period.

An additional model integration was initially designed to combine input-output structures from both Sulaeman & Adzillah (2022) and Nugraha et al. (2019). The resulting model included 4 input and 5 output variables to encompass the broader scope of efficiency measurement. However, due to the limited availability of complete data for all variables, this integrated model could only be constructed for the year 2023. At the time of writing, the integrated model has not been fully analyzed. Its results will be explored in subsequent research. The current study thus focuses on the temporal comparison using the DEA model from Sulaeman and Adzillah (2022) applied to 2017–2019 and newly collected data for 2023.

D. RESULTS AND DISCUSSION

The technical efficiency analysis was conducted for 32 public service universities (PTN-BLU) using an input-oriented Data Envelopment Analysis (DEA) approach under the assumption of variable returns to scale (VRS). Efficiency scores for the years 2017 to 2019 refer to the model applied by Sulaeman and Adzillah [2022], hereafter referred to as Model 2. In addition, this study extends the application of the same model to data from 2023. Meanwhile, the efficiency results derived from the approach used by Nugraha et al. (2019) are referred to as Model 1.

Table 1. Technical Efficiency Scores (MaxDEA, R) and comparison with Sulaeman and Adzilah (2022), presents the technical efficiency results for 2017 using Model 1 (MaxDEA and R script) alongside the corresponding results by Sulaeman and Adzillah [3]. This allows a direct year-specific comparison between models.

Table 1 Technical Efficiency Scores (with MaxDEA and R) and comparison with Sulaeman and Adzilah (2022)

| No. | PTN - BLU | Eff. Score | MaxDEA out | | MaxDEA, in | | R vrs, in | |
|-----|------------------------------------|------------|------------|------|------------|------------|-----------|--|
| | | | Score | Cek | Score | Eff. Score | Cek | |
| 1 | Politeknik Negeri Malang | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 2 | Universitas Brawijaya | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 3 | Universitas Negeri Malang | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 4 | Universitas Sebelas Maret | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 5 | Universitas Terbuka | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 6 | Universitas Pendidikan Ganesha | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 7 | Universitas Negeri Semarang | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 8 | Universitas Negeri Jakarta | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 9 | Universitas Sultan Ageng Tirtayasa | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 10 | Universitas Sriwijaya | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 11 | Universitas Negeri Padang | 0,8977 | 0,8977 | TRUE | 0,9091 | 0,9091 | TRUE | |
| 12 | Universitas Negeri Surabaya | 1,0000 | 1,0000 | TRUE | 1,0000 | 1,0000 | TRUE | |
| 13 | Universitas Negeri Yogyakarta | 0,8697 | 0,8697 | TRUE | 0,8799 | 0,8799 | TRUE | |
| 14 | Universitas Riau | 0,7141 | 0,7141 | TRUE | 0,7308 | 0,7308 | TRUE | |
| 15 | Universitas Jenderal Soedirman | 0,8892 | 0,8892 | TRUE | 0,9092 | 0,9092 | TRUE | |
| 16 | Universitas Andalas | 0,8614 | 0,8614 | TRUE | 0,8730 | 0,8730 | TRUE | |
| 17 | Universitas Halu Oleo | 0,8032 | 0,8032 | TRUE | 0,8204 | 0,8204 | TRUE | |
| 18 | Universitas Lampung | 0,8109 | 0,8109 | TRUE | 0,8229 | 0,8229 | TRUE | |
| 19 | Universitas Udayana | 0,6302 | 0,6302 | TRUE | 0,6690 | 0,6690 | TRUE | |
| 20 | Universitas Bengkulu | 0,7315 | 0,7315 | TRUE | 0,7736 | 0,7736 | TRUE | |
| 21 | Universitas Mataram | 0,6907 | 0,6907 | TRUE | 0,7322 | 0,7322 | TRUE | |
| 22 | Universitas Mulawarman | 0,6462 | 0,6462 | TRUE | 0,6748 | 0,6748 | TRUE | |
| 23 | Universitas Tadulako | 0,5588 | 0,5588 | TRUE | 0,6033 | 0,6033 | TRUE | |
| 24 | Universitas Negeri Gorontalo | 0,5874 | 0,5874 | TRUE | 0,6783 | 0,6783 | TRUE | |

Table 2. Technical Efficiency Scores (R) and Comparison with Sulaeman and Adzilah (2022) for year 2017–2019 provides the yearly efficiency results for 2017–2019, calculated using the R script implementation of Model 2. The findings show considerable variation in technical efficiency across the 32 PTN-BLU. While some institutions consistently achieved full efficiency over three consecutive years, others remained persistently inefficient.

Table 2. Technical Efficiency Scores (R) and Comparison with Sulaeman and Adzillah (2022) for year 2017–2019

| No | PTN – BLU | Sulaeman dan Adzillah (2020) | | | | | Penelitian ini | | | | |
|----|------------------------------------|------------------------------|--------|--------|--------|------|----------------|--------|--------|--------|------|
| | | 2017 | 2018 | 2019 | Rata2 | Rank | 2017 | 2018 | 2019 | Rata2 | Rank |
| 1 | Politeknik Negeri Malang | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 2 | Universitas Brawijaya | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 3 | Universitas Negeri Malang | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 4 | Universitas Sebelas Maret | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 5 | Universitas Terbuka | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 6 | Universitas Pendidikan Ganesha | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 1 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 7 | Universitas Negeri Semarang | 1,0000 | 1,0000 | 0,9647 | 0,9882 | 7 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 8 | Universitas Negeri Jakarta | 1,0000 | 0,9465 | 0,9705 | 0,9723 | 8 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 9 | Universitas Sultan Ageng Tirtayasa | 1,0000 | 0,9708 | 0,9221 | 0,9643 | 9 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 10 | Universitas Sriwijaya | 1,0000 | 1,0000 | 0,8803 | 0,9601 | 10 | 1,0000 | 1,0000 | 1,0000 | 1,0000 | 5,5 |
| 11 | Universitas Negeri Padang | 0,8977 | 0,9626 | 1,0000 | 0,9534 | 11 | 0,9091 | 1,0000 | 1,0000 | 0,9697 | 11 |
| 12 | Universitas Negeri Surabaya | 1,0000 | 1,0000 | 0,8507 | 0,9502 | 12 | 1,0000 | 0,9092 | 0,9092 | 0,9394 | 12 |
| 13 | Universitas Negeri Yogyakarta | 0,8697 | 0,9274 | 1,0000 | 0,9323 | 13 | 0,8799 | 0,9091 | 0,9091 | 0,8994 | 13 |
| 14 | Universitas Riau | 0,7141 | 1,0000 | 0,9297 | 0,8812 | 14 | 0,7308 | 0,8799 | 0,8799 | 0,8302 | 16 |
| 15 | Universitas Jenderal Soedirman | 0,8892 | 0,8638 | 0,8513 | 0,8681 | 15 | 0,9092 | 0,8730 | 0,8730 | 0,8850 | 14 |
| 16 | Universitas Andalas | 0,8614 | 0,8888 | 0,8303 | 0,8602 | 16 | 0,8730 | 0,8229 | 0,8229 | 0,8396 | 15 |
| 17 | Universitas Halu Oleo | 0,8032 | 0,9031 | 0,8265 | 0,8442 | 17 | 0,8204 | 0,8204 | 0,8204 | 0,8204 | 17 |
| 18 | Universitas Lampung | 0,8109 | 0,8742 | 0,7783 | 0,8212 | 18 | 0,8229 | 0,7736 | 0,7736 | 0,7900 | 18 |
| 19 | Universitas Udayana | 0,6302 | 0,9140 | 0,8907 | 0,8116 | 19 | 0,6690 | 0,7322 | 0,7322 | 0,7111 | 20 |

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|----|------------------------------|--------|--------|--------|--------|----|--------|--------|--------|--------|----|
| 20 | Universitas Bengkulu | 0,7315 | 0,7896 | 0,7179 | 0,7463 | 20 | 0,7736 | 0,7308 | 0,7308 | 0,7451 | 19 |
| 21 | Universitas Mataram | 0,6907 | 0,7039 | 0,8021 | 0,7322 | 21 | 0,7322 | 0,6783 | 0,6783 | 0,6963 | 21 |
| 22 | Universitas Mulawarman | 0,6462 | 0,7925 | 0,6524 | 0,6970 | 22 | 0,6748 | 0,6748 | 0,6748 | 0,6748 | 22 |
| 23 | Universitas Tadulako | 0,5588 | 0,7490 | 0,6743 | 0,6607 | 23 | 0,6033 | 0,6690 | 0,6690 | 0,6471 | 23 |
| 24 | Universitas Negeri Gorontalo | 0,5874 | 0,6614 | 0,6999 | 0,6496 | 24 | 0,6783 | 0,6033 | 0,6033 | 0,6283 | 24 |

Table 3. Technical Efficiency Scores in 2023 based on Sulaeman and Adilah (2022) and Model R Script reports the 2023 efficiency results, also based on Model 2. Among the 48 Decision Making Units (DMUs) assessed, only 21 achieved full efficiency. This means approximately 43.75% of the DMUs remained inefficient in 2023, indicating that although the model can identify efficient institutions, substantial opportunities for improvement remain.

Table 3. Technical Efficiency Scores in 2023-SA (2022) Model, R Script reports the 2023 efficiency results, also based on Model 2

| No | DMU Name | Effi. Score | Rank | InputSlack | OutputSlack | Peers |
|----|-------------------------------|-------------|------|------------------------------|------------------------------|-------------------------|
| 1 | Universitas Riau | 1 | 1 | 0, 0, 0 | 0, 0, 0 | 1 |
| 2 | Universitas Negeri Medan | 0,894319831 | 29 | 1161.95222645353, 0, 0 | 0, 0, 0 | 5, 6, 8, 15, 21 |
| 3 | Politeknik Negeri Malang | 0,965303385 | 25 | 0, 0, 0 | 0, 0, 0 | 2, 6, 11, 12, 15, 16 |
| 4 | UPN Veteran Yogyakarta | 1 | 2 | 0, 0, 0 | 0, 0, 0 | 2 |
| 5 | Politeknik Negeri Semarang | 0,866613731 | 33 | 0, 0, 0 | 8.2127928714499, 0, 0 | 3, 4, 6, 7, 11 |
| 6 | Politeknik Negeri Bali | 0,746266881 | 42 | 0, 0, 0 | 35.7350190786176, 0, 0 | 3, 4, 6, 7, 11 |
| 7 | Politeknik Manufaktur Bandung | 1 | 3 | 0, 0, 0 | 0, 0, 0 | 3 |
| 8 | Universitas Bengkulu | 0,8299619 | 36 | 0, 0, 0 | 0, 0, 0 | 4, 6, 10, 15, 16, 21 |
| 9 | Politeknik Negeri Medan | 1 | 4 | 0, 0, 0 | 0, 0, 0 | 4 |
| 10 | Politeknik Negeri Jember | 0,782383793 | 40 | 312.229474590582, 0, 0 | 0, 842.762977115158, 0 | 2, 10, 11, 16 |
| 11 | Universitas Negeri Makassar | 1 | 5 | 0, 0, 0 | 0, 0, 0 | 5 |
| 12 | Universitas Jambi | 0,837492052 | 35 | 0, 0, 0 | 42.1716982382538, 0, 0 | 4, 5, 6, 8, 15 |
| 13 | Universitas Sriwijaya | 1 | 6 | 0, 0, 0 | 0, 0, 0 | 6 |
| 14 | UPN Veteran Jakarta | 1 | 7 | 0, 0, 0 | 0, 0, 0 | 7 |
| 15 | UPN Veteran Jawa Timur | 1 | 8 | 0, 0, 0 | 0, 0, 0 | 8 |
| 16 | Universitas Sam Ratulangi | 0,679896099 | 44 | 0, 56.1927601855366, 0 | 0, 1686.13351682782, 0 | 3, 7, 12, 13 |
| 17 | Universitas Haluoleo | 1 | 9 | 0, 0, 0 | 0, 0, 0 | 9 |

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| No | DMU Name | Effi. Score | Rank | InputSlack | OutputSlack | Peers |
|----|---------------------------------------|-------------|------|---------------------------------------|---|----------------------|
| 18 | Universitas Pendidikan Ganesha | 0,876085185 | 32 | 0, 0, 0 | 0, 0, 0 | 2, 6, 7, 8, 11, 15 |
| 19 | Universitas Tanjungpura | 0,945145314 | 26 | 26568.3460768855, 0, 127204232563.184 | 18.6626577426032, 559.535892710271, 0 | 6, 8 |
| 20 | Politeknik Negeri Batam | 1 | 10 | 0, 0, 0 | 0, 0, 0 | 10 |
| 21 | Politeknik Perkapalan Negeri Surabaya | 1 | 11 | 0, 0, 0 | 0, 0, 0 | 11 |
| 22 | Universitas Pattimura, Maluku | 0,702705727 | 43 | 0, 0, 0 | 41.1070381041976, 0, 0 | 4, 6, 15, 17, 18 |
| 23 | Universitas Jenderal Soedirman | 1 | 12 | 0, 0, 0 | 0, 0, 0 | 12 |
| 24 | Politeknik Negeri Jakarta | 0,864211764 | 34 | 0, 0, 0 | 22.5725135872783, 0, 0 | 3, 4, 6, 7, 11 |
| 25 | Universitas Lampung | 0,895488314 | 28 | 2857.1630580573, 0, 0 | 0, 73.7635595425804, 0 | 5, 6, 7, 8 |
| 26 | Universitas Lambung Mangkurat | 0,993270635 | 22 | 540.164300005719, 18.5217940190154, 0 | 0, 0, 0 | 6, 12, 17, 18 |
| 27 | Universitas Udayana | 1 | 13 | 0, 0, 0 | 0, 0, 0 | 13 |
| 28 | Universitas Mataram | 1 | 14 | 0, 0, 0 | 0, 0, 0 | 14 |
| 29 | Universitas Nusa Cendana | 0,881230661 | 30 | 0, 0, 0 | 129.616041793365, 0, 0 | 4, 5, 6, 17, 18 |
| 30 | Universitas Negeri Jakarta | 0,878165212 | 31 | 6584.18824542274, 0, 121964888540.912 | 0, 0, 0 | 6, 10, 11, 16 |
| 31 | ISI Padang Panjang | 0,819379929 | 37 | 0, 0, 0 | 11.704532549584, 75.6056536408572, 17951445390.8692 | 3, 15, 20 |
| 32 | Politeknik Negeri Bandung | 1 | 15 | 0, 0, 0 | 0, 0, 0 | 15 |
| 33 | Universitas Palangka Raya | 0,619319393 | 46 | 0, 0, 0 | 17.9007609246788, 0, 0 | 4, 6, 8, 11, 15 |
| 34 | Universitas Jember | 1 | 16 | 0, 0, 0 | 0, 0, 0 | 16 |
| 35 | Universitas Tadulako | 1 | 17 | 0, 0, 0 | 0, 0, 0 | 17 |
| 36 | Universitas Singaperbangsa | 0,972257227 | 24 | 0, 0, 0 | 36.1370146410528, 0, 0 | 6, 7, 8, 11, 15 |
| 37 | Universitas Mulawarman | 0,942833591 | 27 | 0, 0, 0 | 0, 0, 0 | 4, 6, 12, 15, 16, 21 |
| 38 | Universitas Khairun Ternate | 0,529587879 | 47 | 0, 0, 0 | 22.8452640949999, 0, 0 | 4, 6, 7, 11, 15 |
| 39 | Universitas Sultan Ageng Tirtayasa | 0,811839045 | 38 | 0, 0, 0 | 21.7659827754316, 0, 0 | 4, 5, 6, 8, 15 |
| 40 | Universitas Negeri Gorontalo | 0,798514456 | 39 | 835.343601888768, 0, 0 | 0, 0, 0 | 4, 6, 8, 16, 21 |
| 41 | Universitas Negeri Manado | 0,506010669 | 48 | 0, 0, 0 | 36.1502453256476, 0, 0 | 3, 4, 7, 11, 15 |
| 42 | Politeknik Negeri Ujung Pandang | 0,779236171 | 41 | 0, 0, 0 | 55.4143977415315, 0, 0 | 3, 4, 6, 7, 11 |

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| No | DMU Name | Effi. Score | Rank | InputSlack | OutputSlack | Peers |
|----|------------------------------|-------------|------|------------------------|------------------------|-----------------|
| 43 | Universitas Cendrawasih | 1 | 18 | 0, 0, 0 | 0, 0, 0 | 18 |
| 44 | Universitas Trunojoyo Madura | 0,988233761 | 23 | 5194.81095532784, 0, 0 | 23.4483145852296, 0, 0 | 4, 5, 10, 21 |
| 45 | Politeknik Negeri Pontianak | 1 | 19 | 0, 0, 0 | 0, 0, 0 | 19 |
| 46 | Universitas Bangka Belitung | 1 | 20 | 0, 0, 0 | 0, 0, 0 | 20 |
| 47 | Politeknik Negeri Sriwijaya | 0,644826366 | 45 | 0, 0, 0 | 48.7486290956863, 0, 0 | 4, 6, 8, 11, 15 |
| 48 | Universitas Malikussaleh | 1 | 21 | 0, 0, 0 | 0, 0, 0 | 21 |

Table 4. Comparison of Efficient Institutions across Model 1 and Model 2 summarizes the overlap of efficient institutions between both models. Although both models identify a similar number of efficient DMUs (20 in Model 1, 21 in Model 2), only 11 institutions are identified as efficient by both approaches.

Table 4. Comparison of Efficient Institutions across Model 1 and Model 2

| No | Model 1 | | | Model 2 | | |
|----|---------------------------------------|------------|------|---------------------------------------|------------|------|
| | dmu_names | Eff. Score | Rank | dmu_names | Eff. Score | Rank |
| 1 | Universitas Riau | 1 | 1 | Universitas Riau | 1 | 1 |
| 4 | UPN Veteran Yogyakarta | 1 | 2 | UPN Veteran Yogyakarta | 1 | 2 |
| 5 | Politeknik Negeri Semarang | 1 | 3 | Politeknik Manufaktur Bandung | 1 | 3 |
| 6 | Politeknik Negeri Bali | 1 | 4 | Politeknik Negeri Medan | 1 | 4 |
| 7 | Politeknik Manufaktur Bandung | 1 | 5 | Universitas Negeri Makassar | 1 | 5 |
| 9 | Politeknik Negeri Medan | 1 | 6 | Universitas Sriwijaya | 1 | 6 |
| 10 | Politeknik Negeri Jember | 1 | 7 | UPN Veteran Jakarta | 1 | 7 |
| 14 | UPN Veteran Jakarta | 1 | 8 | UPN Veteran Jawa Timur | 1 | 8 |
| 18 | Universitas Pendidikan Ganesha | 1 | 9 | Universitas Haluoleo | 1 | 9 |
| 20 | Politeknik Negeri Batam | 1 | 10 | Politeknik Negeri Batam | 1 | 10 |
| 21 | Politeknik Perkapalan Negeri Surabaya | 1 | 11 | Politeknik Perkapalan Negeri Surabaya | 1 | 11 |
| 23 | Universitas Jenderal Soedirman | 1 | 12 | Universitas Jenderal Soedirman | 1 | 12 |
| 27 | Universitas Udayana | 1 | 13 | Universitas Udayana | 1 | 13 |
| 30 | Universitas Negeri Jakarta | 1 | 14 | Universitas Mataram | 1 | 14 |
| 31 | ISI Padang Panjang | 1 | 15 | Politeknik Negeri Bandung | 1 | 15 |
| 32 | Politeknik Negeri Bandung | 1 | 16 | Universitas Jember | 1 | 16 |
| 34 | Universitas Jember | 1 | 17 | Universitas Tadulako | 1 | 17 |
| 36 | Universitas Singaperbangsa | 1 | 18 | Universitas Cendrawasih | 1 | 18 |
| 37 | Universitas Mulawarman | 1 | 19 | Politeknik Negeri Pontianak | 1 | 19 |
| 47 | Politeknik Negeri Sriwijaya | 1 | 20 | Universitas Bangka Belitung | 1 | 20 |
| 2 | Universitas Negeri Medan | 0,987932 | 21 | Universitas Malikussaleh | 1 | 21 |

In addition, Figures 1, 2, and 3 provide descriptive analyses of key input and output variables:

Figure 1. Descriptive Analysis of the Number of Study Programs

Figure 2. Descriptive Analysis of the Number of International Publications

Figure 3. Descriptive Analysis of PNBPN Revenue (in billion Rupiah)

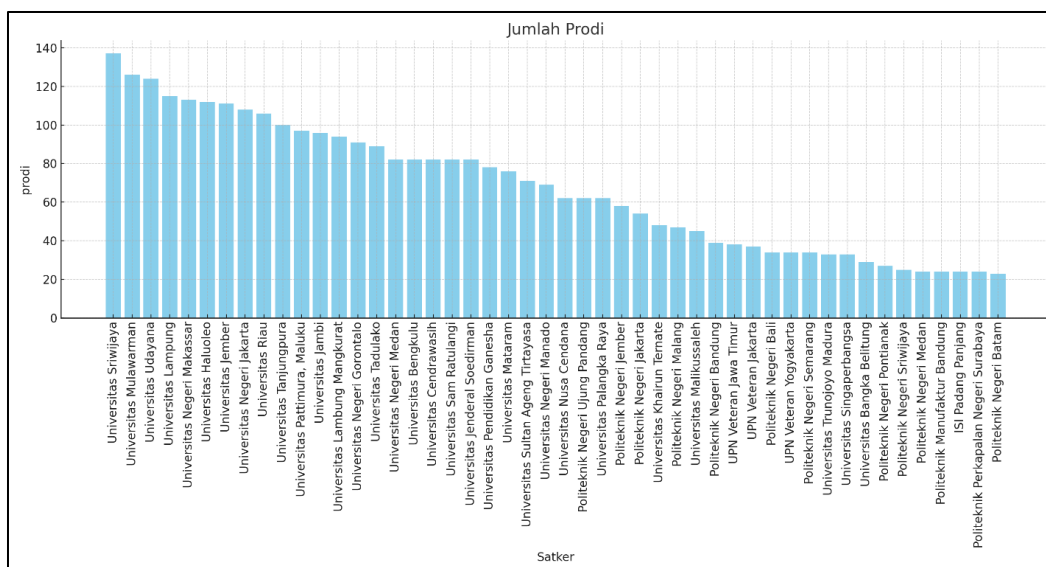


Figure 1. Descriptive Analysis of the Number of Study Programs

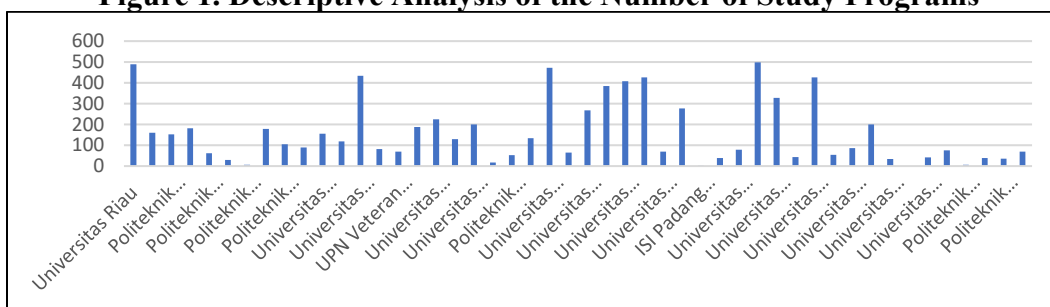


Figure 2. Descriptive Analysis of the Number of International Publications

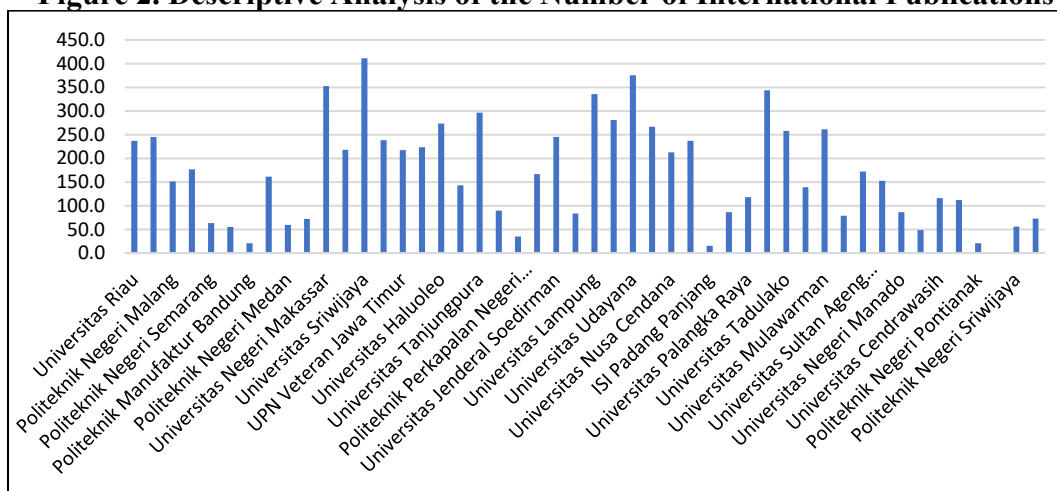


Figure 3. Descriptive Analysis of PNPB Revenue (in billion Rupiah)

These graphs support the interpretation of the DEA results by describing variability in input and output measures among DMUs.

The findings presented in Tables 1 through 4 reveal several notable patterns regarding the technical efficiency levels of public service universities (PTN-BLU) in Indonesia. The results from Table 1 (Technical Efficiency Scores-MaxDEA, R-2017) through Figure 1-3 (Descriptive Analysis) indicate that while a few institutions consistently maintained efficiency from 2017 to 2019, only a limited number managed to retain such performance in 2023. This may suggest the

presence of structural changes, internal institutional dynamics, or the impact of new policy interventions that affected university efficiency in more recent years.

In comparing the two DEA models, a key insight is the substantial difference in identifying efficient Decision Making Units (DMUs). Although both Model 1 and Model 2 employ the same number of variables, they differ in the composition of input and output variables. This variation yields markedly different results. For instance, Universitas Cenderawasih was ranked among the most efficient in Model 2 but was among the least efficient in Model 1. This finding underscores the sensitivity of DEA outcomes to the selection of input-output combinations and highlights the importance of aligning model specifications with institutional performance dimensions.

Further, the slack analysis reveals that for many inefficient DMUs, improvements are required not only on the input side but also in terms of outputs. In several cases, increases in international publications, program accreditation, or graduate output are critical factors for achieving efficiency. Consequently, performance improvement strategies should be tailored to the specific inefficiencies of each institution.

The integrative longitudinal approach introduced in Table 5 (displayed partially) represents a significant step toward obtaining a time-series perspective of efficiency. However, the integration was constrained by the limited number of institutions for which consistent data were available and by methodological differences across previous studies. Only 15 out of 48 DMUs could be included in this longitudinal synthesis. This highlights the urgent need for standardized formats and more complete data availability across time to support robust long-term efficiency trend analyses.

| No | New Data of 2023 | No | Sulaeman & Adzillah (2022) | Integration | No | Anugrah et al. (2019) |
|----|---------------------------------------|----|----------------------------|-------------|----|-----------------------|
| 1 | ISI Padang Panjang | | | | | |
| 2 | Politeknik Manufaktur Bandung | | | | | |
| 3 | Politeknik Negeri Bali | | | | | |
| 4 | Politeknik Negeri Bandung | | | | | |
| 5 | Politeknik Negeri Batam | | | | | |
| 6 | Politeknik Negeri Jakarta | | | | | |
| 7 | Politeknik Negeri Jember | | | | | |
| 8 | Politeknik Negeri Malang | 1 | Politeknik Negeri Malang | 1 | | |
| 9 | Politeknik Negeri Medan | | | | | |
| 10 | Politeknik Negeri Pontianak | | | | | |
| 11 | Politeknik Negeri Semarang | | | | | |
| 12 | Politeknik Negeri Sriwijaya | | | | | |
| 13 | Politeknik Negeri Ujung Pandang | | | | | |
| 14 | Politeknik Perkapalan Negeri Surabaya | | | | | |
| 15 | UPN Veteran Jakarta | | | | | |
| 16 | UPN Veteran Jawa Timur | | | | | |
| 17 | UPN Veteran Yogyakarta | | | | | |
| 18 | Universitas Bangka Belitung | | | | | |
| 19 | Universitas Bengkulu | 2 | Universitas Bengkulu | 2 | 1 | Universitas Bengkulu |
| 20 | Universitas Cendrawasih | | | | | |

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| No | New Data of 2023 | No | Sulaeman & Adzillah (2022) | Integration | No | Anugrah et al. (2019) |
|----|--------------------------------|----|--------------------------------|-------------|----|--------------------------------|
| 21 | Universitas Haluoleo | 3 | Universitas Halu Oleo | 3 | | |
| 22 | Universitas Jambi | | | | | |
| 23 | Universitas Jember | | | | | |
| 24 | Universitas Jenderal Soedirman | 4 | Universitas Jenderal Soedirman | 4 | 2 | Universitas Jenderal Soedirman |

Meanwhile, the integrative model presented in Table 16, which merges a wider array of input and output variables, offers a promising direction for capturing institutional efficiency more holistically. This model incorporates nine variables covering academic performance, financial metrics, and institutional outcomes. Unfortunately, due to time and scope limitations, this comprehensive model was not explored in depth in the current study. Future research should expand on this model to derive policy-relevant insights and support evidence-based decision-making in higher education resource allocation and performance management.

| Input-Output Model Combination (1-4 Input, 5-9 Output) | Model 1 Anugerah (2019) | Model 2 Sulaeman & Adzillah (2022) | Model Integration This Research |
|--|-------------------------|------------------------------------|---------------------------------|
| Number of students | √ | √ | √ |
| Number of lecturers | √ | √ | √ |
| Number of study programs | √ | x | √ |
| University expenditure realization | x | √ | √ |
| Number of publications indexed by Scopus | √ | √ | √ |
| Study programs accredited A by BAN-PT | √ | x | √ |
| GPA | √ | x | √ |
| Number of graduates | x | √ | √ |
| Total non-tax state revenue from educational services | x | √ | √ |

E. CONCLUSION

The findings presented in Tables 6 through 14 reveal several notable patterns regarding the technical efficiency levels of public service universities (PTN-BLU) in Indonesia. The results from Table 6 (Technical Efficiency Scores – MaxDEA, R – 2017) through Table 8 (Descriptive Analysis of the Number of Study Programs) indicate that while a few institutions consistently maintained efficiency from 2017 to 2019, only a limited number managed to retain such performance in 2023. This may suggest the presence of structural changes, internal institutional dynamics, or the impact of new policy interventions that affected university efficiency in more recent years.

In comparing the two DEA models, a key insight is the substantial difference in identifying efficient Decision Making Units (DMUs). Although both Model 1 and Model 2 employ the same number of variables, they differ in the composition of input and output variables. This variation yields markedly different results. For instance, Universitas Cenderawasih was ranked among the most efficient in Model 2 but was among the least efficient in Model 1. This finding underscores the sensitivity of DEA outcomes to the selection of input-output combinations and highlights the importance of aligning model specifications with institutional performance dimensions.

Further, the slack analysis reveals that for many inefficient DMUs, improvements are required not only on the input side but also in terms of outputs. In several cases, increases in international publications, program accreditation, or graduate output are critical factors for achieving efficiency. Consequently, performance improvement strategies should be tailored to the specific inefficiencies of each institution.

The integrative longitudinal approach introduced in Table 15 represents a significant step toward obtaining a time-series perspective of efficiency. However, the integration was constrained by the limited number of institutions for which consistent data were available and by methodological differences across previous studies. Only 15 out of 48 DMUs could be included in this longitudinal synthesis. This highlights the urgent need for standardized formats and more complete data availability across time to support robust long-term efficiency trend analyses.

Meanwhile, the integrative model presented in Table 16, which merges a wider array of input and output variables, offers a promising direction for capturing institutional efficiency more holistically. This model incorporates nine variables covering academic performance, financial metrics, and institutional outcomes. Unfortunately, due to time and scope limitations, this comprehensive model was not explored in depth in the current study. Future research should expand on this model to derive policy-relevant insights and support evidence-based decision-making in higher education resource allocation and performance management.

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