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Efficiency of the Realization of the 20% Budget for the Development of Educational Infrastructure: Case Study of 33 Regencies/Cities in North Sumatra Province

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A B S T R A C T

The policy requiring at least 20% of the education budget aims to improve regional education quality, but its success depends on efficient management. This study analyzes the efficiency of education expenditure realization and GDP per capita in supporting regional education infrastructure development across 33 districts/cities in North Sumatra Province. Using Data Envelopment Analysis (DEA) with an input-oriented approach, each district/city was treated as a decision-making unit. The findings reveal significant efficiency variations among regions. Most areas show moderate efficiency, while only a few achieve optimal performance and serve as benchmarks. The results indicate that larger budgets and stronger economic capacity do not automatically enhance education development without efficient governance and effective budget management.

INTRODUCTION

Education is a key pillar in human resource development and plays a strategic role in encouraging long-term economic growth and poverty reduction. Investment in the education sector has been proven to increase labor productivity, expand economic opportunities, and strengthen regional competitiveness (Becker, 1993; Hanushek & Woessmann, 2012). However, various international studies have shown that increased education spending does not automatically result in an improvement in the quality of education if it is not accompanied by efficient budget management and good institutional governance (Gupta & Verhoeven, 2001; Afonso & Aubyn, 2005).

In Indonesia, the state's commitment to education development is realized through the policy of allocating at least 20% of the local government budget to the education sector. This policy is expected to be able to improve access, quality, and equity of education services between regions. However, a number of studies show that the achievement of education development between regions still shows significant inequality, even though the amount of budget allocation is relatively uniform (World Bank, 2020; Alderman et al., 2022). This condition indicates that the main problem lies not only in the amount of the budget, but also in the efficiency of its utilization.

Studies of public economics and regional development emphasize that differences in the performance of education development are often influenced by variations in the technical efficiency and institutional capacity of local governments. Regions with large fiscal capacity are not always able to convert budget inputs into optimal educational outputs (Afonso et al., 2010). This emphasizes the importance of evaluating the efficiency of public spending as a policy instrument to improve the quality of education development in a sustainable manner.

In this context, *Data Envelopment Analysis* (DEA) is a relevant approach to evaluate the relative efficiency of local governments in managing education spending. DEA allows the measurement of relative performance between *decision-making units* by considering many inputs and outputs simultaneously, without requiring a specific form of production function (Charnes et al., 1978; Cooper et al., 2007). This method has been widely used in international studies to assess the efficiency of the public sector, including the education sector, due to its ability to identify best practices and policy benchmarks (Coelli et al., 2005).Based on this background, this study aims to analyze the efficiency of the realization of education expenditure of 20% and GDP per capita against the Regional Education Development Index (IPPD) in 33 districts/cities of North Sumatra Province. In addition to measuring the level of technical efficiency, the study also identifies benchmark areas and evaluates gaps between actual and optimal conditions. Thus, this research is expected to make an empirical contribution to the formulation of regional education policies that are more effective, performance-based, and oriented towards equitable distribution of education quality.

THEORETICAL REVIEW

Education Expenditure and Regional Education Development

Education spending is seen as a form of public investment that generates long-term returns through improving the quality of human resources. Human capital theory states that increased investment in education contributes to economic growth and social welfare (Becker, 1993). However, studies have shown that the amount of education spending does not always go hand in hand with improving educational attainment, especially when budget management is inefficient and not on target (Gupta & Verhoeven, 2001).

Modern education development measurement approaches tend to use composite indicators that reflect various dimensions of education, including access, quality, and educational outcomes. The use of education development indices is in line with international practice that emphasizes multidimensional evaluation rather than single indicators such as school participation rates or per capita expenditure (UNESCO, 2015). In this context, IPPD is a relevant instrument to measure the quality of regional education development more comprehensively.

Public Sector Efficiency and Data Envelopment Analysis (DEA)

The concept of efficiency in the public sector is rooted in Farrell's (1957) thought, which distinguishes between technical efficiency and allocative efficiency. This concept was later developed by Charnes et al. (1978) through DEA as a non-parametric method for measuring the relative efficiency of decision-making units. DEA is particularly suitable for the public sector because it is able to accommodate many heterogeneous inputs and outputs.

In the education sector, DEA has been widely used to evaluate the efficiency of schools, universities, and local governments. Coelli et al. (2005) assert that DEA not only identifies efficient and inefficient units, but also provides important information through slacks analysis and peer comparison. Thus, DEA functions as an evaluation tool as well as an instrument for the formulation of learning-based policies between units.

GDP Per Capita and Regional Economic Capacity

GDP per capita reflects the economic capacity of a region in providing public services, including education. Empirical studies show that regions with higher GDP per capita tend to have greater fiscal capacity to support educational development (Afonso et al., 2010). However, the relationship between economic capacity and educational performance is not always linear, as it is influenced by the quality of governance and efficiency of public spending.

Several studies show that regions with limited economic resources can still achieve relatively good educational performance if they are able to manage the budget efficiently and results-oriented (Fried et al., 2008). These findings strengthen the argument that the efficiency of budget management determines the success of education development more than just the amount of economic input.

Benchmarking and Inter-Regional Learning

Benchmarking is an important approach in improving public sector performance through learning from better-performing units. Within the framework of DEA, benchmarking allows the identification of efficient frontiers that can be used as policy reference by inefficient units (Cooper et al., 2007). This approach is in line with the evidence-based policy paradigm that emphasizes the use of empirical evidence in public policy formulation.

Fried et al. (2008) emphasize that DEA-based benchmarking is not only evaluative, but also transformative, as it allows for the transfer of best practices between regions. In the development of regional education, this approach is very relevant to reduce inequality between regions and improve the equitable distribution of education quality through the adoption of policies that have been proven effective.

METHODOLOGY

Research Approach

This study uses a quantitative approach to measure the efficiency of the realization of the 20% education budget and GDP per capita in improving the Regional Education Development Index (IPPD) across 33 regencies/cities in North Sumatra. The analysis treats each regency/city as a Decision-Making Unit (DMU).

Data Types and Sources

The research utilizes secondary data for the period 2019–2022. Data were obtained from:

a. Badan Pusat Statistik (BPS) of North Sumatra Province
b. Ministry of Finance
c. Provincial planning documents and relevant literature

Variables

The study applies an input–output framework consisting of:

Inputs:

a. Realization of 20% education expenditure from the total regional budget.
b. Gross Regional Domestic Product (GRDP) per capita.

Output:

Regional Education Development Index (IPPD)

The inputs reflect fiscal commitment and regional economic capacity, while the output represents the level of regional education development performance.

Analytical Method

The study employs Data Envelopment Analysis (DEA) with an input-oriented model, as developed by Abraham Charnes, William W. Cooper, and Edward Rhodes (1978). DEA is a non-parametric linear programming technique used to measure the relative technical efficiency of DMUs by comparing multiple inputs and outputs simultaneously without requiring a specific functional form.

The input-oriented approach aims to determine the minimum level of inputs required to produce a given level of output. Efficiency scores range from 0 to 1, where:

a. Score = 1 indicates technically efficient regions (on the efficiency frontier)
b. Score < 1 indicates inefficient regions

Stages of Analysis

The DEA analysis in this study consists of three main stages:

1. Efficiency Score Calculation
   Measuring the technical efficiency level of each regency/city.
2. Benchmarking Analysis
   Identifying efficient regions that serve as reference peers for inefficient regions.
3. Actual vs. Optimal Comparison
   Comparing actual and optimal levels of education expenditure and GDP per capita to determine necessary budget reallocation for achieving optimal efficiency.

Through this methodology, the study evaluates how effectively regional governments convert education expenditure and economic capacity into improvements in regional education development.

RESULTS

Results of Analysis of Expenditure Realization Efficiency Score and Per Capita GDP

Based on Table 2 in the low category (efficiency score 0.00–0.50), there are a total of 9 districts/cities or 27.27% of the total 33 districts/cities. This distribution includes 1 district/city with a score of 0.00–0.30 (3.03%) and 8 districts/cities with a score of 0.31–0.50 (24.24%). This shows that almost one-third of districts/cities have low efficiency levels, which indicates a significant need for performance improvement in these areas. This indicates that most areas are at a moderate level of efficiency and still need to optimize input management to improve output performance.

Table 2. List of Districts/Cities with Efficiency Scores

No	Efficiency Score	Number of Regencies/Cities	% Regency/city	Categories
1	0.00 - 0.30	1	3.03	Low
2	0.31 - 0.40	4	12.12	
3	0.41 - 0.50	4	12.12	
4	0.51 - 0.60	7	21.21	Medium
5	0.61 - 0.70	4	12.12	
6	0.71 - 0.80	6	18.18	
7	0.81 - 0.90	2	6.06	Height
8	0.91 - 1.00	2	6.06	
9	1.00	3	9.09	
Quantity		33	100	

Source: Research Results. 2024

Table 3 presents the benchmarking results for each regency/city. In DEA, inefficient regions are projected onto the efficiency frontier through reference to efficient regions known as peers. The peer weight reflects the relative contribution of benchmark regions in guiding inefficient units toward optimal performance.

The results indicate that Pematangsiantar City and Pakpak Bharat Regency frequently appear as dominant benchmark regions with high peer weight values. This suggests that their budget management strategies and education development policies are relatively more effective in converting inputs into improved IPPD outcomes.

The repeated appearance of these regions as benchmarks highlights their potential role as models for inter-regional learning and policy replication.

Table 3. Benchmark and Weighting of Regencies/Cities to Achieve Optimal IPPD

No	Regency/City	Benchmarks		Peer Weights	
		Regency/City	Regency/City	Regency/City	Regency/City
1	Expect	23	22	0.613	0.026
2	Coal	22	23	0.527	0.148
3	Binjai	23	22	0.768	0.129
4	Düsseldorf	22	23	0.301	0.521
5	Deli Serdang	23	14	0.527	0.414
6	São Paulo	23	22	0.198	0.77
7	Humbang Hasundutan	22	23	0.727	0.252
8	Dodge	23	22	0.43	0.389
9	North Labuanbatu	22	23	0.894	0.045
10	Labuhan Batu	23	22	0.574	0.043

11	South Labuhanbatu	23	22	0.625	0.041
12	Stuttgart	23	14	0.556	0.174
13	Born in Mandailing	14	23	0.147	0.481
14	Field	14		1	
15	Nias	14	23	0.008	0.338
16	West Nias	22	23	0.444	0.188
17	South Nias	22	23	0.018	0.367
18	North Nias	14	23	0.055	0.295
19	Padang Lawas	22	23	0.029	0.651
20	North Padang Lawas	22	23	0.093	0.568
21	São Paulo	22	23	0.555	0.555
22	Pakpak Bharat	22		1	
23	Pematangsiantar	23		1	
24	Samosir	22	23	0.059	0.682
25	Serdang Bedagai	14	23	0.015	0.616
26	Sibolga	23	22	0.248	0.627
27	Simalungun	23	14	0.619	0.113
28	Tanjungbalai	22		0.776	
29	South Tapanuli	23	14	0.591	0.062
30	Central Tapanuli	22	23	0.393	0.428
31	North Tapanuli	23	22	0.65	0.315
32	High Cliffs	23	22	0.204	0.606
33	Toba Samosir	22	23	0.054	0.758

Source: Research Results, 2024

Table 4 compares the actual realization of education expenditure and GDP per capita with their optimal projected values. The analysis reveals substantial gaps between actual and optimal inputs in several regions. Large negative reallocation values indicate input inefficiency, meaning that some regions allocate more resources than required to achieve their current IPPD level. For example, several regencies show significant differences between actual and optimal expenditure, suggesting potential budget inefficiencies.

Conversely, Medan City, Pakpak Bharat Regency, and Pematangsiantar City show no gap between actual and optimal values, confirming that their resource utilization is aligned with the efficiency frontier.

These findings demonstrate that increasing education budgets alone does not guarantee improved educational development performance. Instead, effective budget management and governance play a crucial role in determining efficiency outcomes.

Table 4. Actual and Optimal Realization of 20% Expenditure and Regional GDP Per Capita

No	Regency/City	Actual Re2alization	Optimal Realization	Reallocation	Actual GDP	Optimal GDP	Reallocation
1	Expect	332,005,921	118,691,706	-213,314,214	35,362,413	12,642,018	-22,720,394
2	Coal	245,921,480	85,405,072	-160,516,407	59,051,509	20,507,758	-38,543,750
3	Binjai	182,646,495	159,275,803	-23,370,691	21,881,093	19,081,278	-2,799,814
4	Düsseldorf	236,467,988	131,140,428	-105,327,559	36,196,440	20,073,823	-16,122,616
5	Deli Serdang	757,164,344	536,686,279	-220,478,064	21,382,207	15,155,939	-6,226,267
6	São Paulo	145,257,869	121,238,218	-24,019,650	35,472,442	29,606,765	-5,865,676
7	Humbang Hasundutan	203,401,865	126,753,243	-76,648,621	46,843,407	29,191,245	-17,652,161
8	Dodge	278,566,947	123,769,204	-154,797,742	47,974,662	21,315,471	-26,659,190
9	North Labuanbatu	207,023,718	105,899,158	-101,124,559	60,261,672	30,825,745	-29,435,926
10	Labuhan Batu	264,529,602	113,127,928	-151,401,673	29,148,006	12,465,347	-16,682,658
11	South Labuhanbatu	186,325,513	122,622,856	-63,702,656	20,319,467	13,372,463	-6,947,003
12	Stuttgart	406,632,457	288,523,046	-118,109,410	18,031,209	12,793,910	-5,237,298
13	Born in Mandailing	322,384,198	246,054,860	-76,329,337	14,448,388	11,027,513	-3,420,874
14	Field	1,057,132,215	1,057,132,215	0	12,191,687	12,191,687	0
15	Nias	180,473,400	72,384,652	-108,088,747	16,447,116	6,596,643	-9,850,472

16	West Nias	139,946,857	83,890,740	-56,056,116	30,829,799	18,480,834	-12,348,964
17	South Nias	298,549,720	71,269,684	-227,280,035	31,982,560	7,634,865	-24,347,694
18	North Nias	172,024,385	113,653,148	-184,896,571	16,641,296	6,335,077	-10,306,218
19	Padang Lawas	219,753,067	126,119,117	-93,633,949	23,470,901	13,470,252	-10,000,648
20	North Padang Lawas	255,664,796	117,445,594	-138,219,201	30,505,582	14,013,451	-16,492,130
21	São Paulo	165,856,558	165,343,780	-512,777	29,355,350	29,264,592	-90,757
22	Pakpak Bharat	108,887,724	108,887,724	0	33,502,056	33,502,056	0
23	Pematangsiantar	188,994,739	188,994,739	0	19,204,986	19,204,986	0
24	Samosir	172,600,425	135,321,498	-37,278,926	19,215,637	15,065,367	-4,150,269
25	Serdang Bedagai	307,102,777	132,396,961	-174,705,815	27,882,597	12,020,637	-15,861,959
26	Sibolga	125,935,147	115,220,809	-10,714,337	28,171,667	25,774,871	-2,396,795
27	Simalungun	452,400,052	236,687,062	-215,712,989	25,350,984	13,263,150	-12,087,833
28	Tanjungbalai	131,068,929	84,550,864	-46,518,064	65,542,277	26,014,207	-23,261,804
29	South Tapanuli	280,247,926	176,767,173	-103,480,752	19,176,708	12,095,762	-7,080,945
30	Central Tapanuli	208,362,929	123,686,814	-84,676,114	36,033,261	21,389,789	-14,643,471
31	North Tapanuli	275,616,430	157,094,378	-118,522,051	40,402,126	23,028,187	-17,373,938
32	High Cliffs	143,531,419	104,620,625	-38,910,793	33,253,991	24,238,967	-9,015,023

33	Toba Samosir	212,515,294	149,192,540	-63,322,753	23,321,216	16,372,240	-6,948,975

Source: Research Results, 2024

DISCUSSION

Education Budget Policy and Efficiency Paradox

The constitutional mandate requiring the allocation of at least 20% of the regional budget to education reflects a strong fiscal commitment to human capital development. However, the findings from 33 regencies/cities in North Sumatra demonstrate that compliance with this allocation rule does not automatically translate into optimal education development outcomes. The DEA results reveal substantial efficiency variation, confirming the existence of what may be termed an "*education budget efficiency paradox":* regions with relatively large fiscal allocations do not necessarily achieve superior educational development performance. This paradox highlights that the effectiveness of public spending depends not merely on budget size, but on the quality of governance, institutional discipline, and strategic allocation mechanisms.

Regions such as Medan, Pakpak Bharat, and Pematangsiantar achieved full efficiency scores, demonstrating that well-managed fiscal resources can produce optimal outcomes even without excessive budget expansion. Their position on the efficiency frontier suggests that these regions have succeeded in aligning planning, implementation, and monitoring mechanisms within the education sector.

Structural Sources of Inefficiency

The presence of a significant number of regions within the low and medium efficiency categories suggests structural inefficiencies in education budget governance. Several factors may explain these conditions:

1. Weak performance-based planning mechanisms.
2. Fragmented coordination between local government units.
3. Limited transparency and accountability systems.
4. Ineffective targeting of education programs.
5. Insufficient monitoring and evaluation frameworks.

The comparison between actual and optimal input levels indicates substantial slack in many districts/cities. This slack represents unused potential efficiency gains. In practical terms, some regions could maintain their current level of IPPD performance while reducing input usage, or alternatively, improve output performance without increasing fiscal allocation if resources were managed more strategically.

This finding supports public sector efficiency theory, which argues that inefficiency often results from institutional weaknesses rather than fiscal scarcity. Thus, policy reform should prioritize managerial and structural improvements over simple budget increases.

Economic Capacity Is Not a Determinant of Efficiency

An important empirical insight from this study is that higher GDP per capita does not guarantee higher efficiency in education development. While economic capacity provides fiscal space for public investment, it does not automatically ensure effective service delivery. Some economically stronger regions remain within the medium efficiency category, indicating that economic advantage alone is insufficient to generate optimal outcomes. Conversely, certain regions with more limited fiscal capacity perform relatively well in terms of efficiency.

This pattern reinforces the argument that *governance quality, institutional effectiveness, and administrative competence* play a more decisive role than pure economic strength. In other words, efficiency is primarily a function of how resources are managed rather than how abundant they are. This has important implications for regional development policy: efforts to stimulate economic growth must be accompanied by parallel improvements in public management systems to ensure that fiscal gains translate into social development outcomes.

Benchmarking as a Strategic Learning Mechanism

The benchmarking analysis shows that Pematangsiantar and Pakpak Bharat frequently emerge as reference units for inefficient regions. Their recurring role as peer benchmarks indicates consistent performance in transforming education expenditure into improved IPPD outcomes.

Benchmarking serves as more than a measurement tool; it is a strategic policy instrument. Through inter-regional learning, less efficient districts can adopt best practices related to:

a. Budget prioritization.
b. Program targeting.
c. Institutional coordination.
d. Monitoring and evaluation systems.
e. Accountability mechanisms.

Rather than applying uniform policy prescriptions across all regions, a benchmarking-based approach allows contextual adaptation. Each district/city can adjust its policy design based on empirical evidence drawn from comparable efficient regions. This approach is aligned with evidence-based policymaking principles and promotes horizontal collaboration between local governments. Over time, such learning mechanisms may reduce inter-regional disparities and foster more equitable education development outcomes.

Implications for Regional Education Governance Reform

The dominance of moderate efficiency levels across North Sumatra suggests that the regional education system is functioning but not yet optimized. This condition requires a strategic shift from an *input-oriented policy mindset to a performance-oriented governance framework.*

Key reform directions include:

a. Strengthening results-based budgeting in the education sector.
b. Enhancing transparency and digital monitoring systems.
c. Conducting periodic efficiency audits using quantitative tools such as DEA.
d. Improving the technical capacity of education planners and budget managers.
e. Institutionalizing benchmarking forums among regencies/cities.

Moreover, the reallocation analysis indicates that significant fiscal space exists within current budgets. Optimizing internal allocation structures may generate performance improvements without increasing total education spending. This is particularly relevant in contexts where fiscal expansion is constrained.

Education Development and Long-Term Regional Competitiveness

Education plays a strategic role in long-term human capital formation and regional competitiveness. Inefficiency in education budget management not only affects short-term infrastructure development but may also undermine future economic growth potential. Therefore, improving technical efficiency is not merely a matter of administrative optimization, but a strategic investment in sustainable development. Efficient regions demonstrate that effective governance can maximize the social return on public expenditure, while inefficient regions risk underutilizing their development potential.

Synthesis

Overall, the findings confirm that disparities in regional education development across North Sumatra are primarily driven by differences in technical efficiency rather than differences in fiscal allocation levels alone.

The study underscores three fundamental conclusions:

1. Budget size does not guarantee performance without efficient governance.
2. Economic capacity must be complemented by strong institutional management.
3. Benchmarking and inter-regional learning provide practical pathways for reducing inefficiency.

By shifting policy orientation toward efficiency optimization, governance strengthening, and empirical benchmarking, regional governments can enhance the effectiveness, equity, and sustainability of education development outcomes.

CONCLUSIONS AND RECOMMENDATIONS

The results of the study show that the variation in the performance of education development between districts/cities is not determined solely by the amount of budget allocation and regional economic capacity, but by the level of efficiency in managing these resources. These findings confirm that increasing education spending without the support of efficient management does not automatically result in an improvement in the quality of education development. The efficiency score distribution reveals that most districts/cities are at a moderate level of efficiency, while only a small number of areas achieve optimal efficiency and serve as a benchmark. Efficient regions have proven to be better able to convert fiscal inputs and economic capacity into better educational

development outputs. On the other hand, many regions with relatively large realization of education spending still show suboptimal performance, as reflected in the gap between actual conditions and optimal conditions.

The benchmarking analysis highlights the importance of inter-regional learning in improving the efficiency of education development. Districts/cities that are not yet efficient have the opportunity to improve their performance through the adoption of budget management practices and education policies from the benchmark areas. In addition, the results of the reallocation analysis indicate that there is significant policy space to reorganize the allocation of education expenditure to be more oriented towards achieving results and performance, rather than simply fulfilling budget allocation provisions.

Overall, this study emphasizes the need for a paradigm shift in regional education policy from an input-based approach to an efficiency and performance-based approach. Strengthening budget governance, increasing transparency and accountability, and utilizing empirical evidence-based benchmarking are key elements in encouraging more effective, equitable, and sustainable regional education development. Thus, optimizing the efficiency of education spending not only contributes to increasing the Regional Education Development Index, but also strengthens the role of education as a strategic instrument in regional development and reducing inequality between regions.

FURTHER STUDY

Optimizing the efficiency of education spending not only contributes to increasing the Regional Education Development Index, but also strengthens the role of education as a strategic instrument in regional development and reducing inequality between regions.

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