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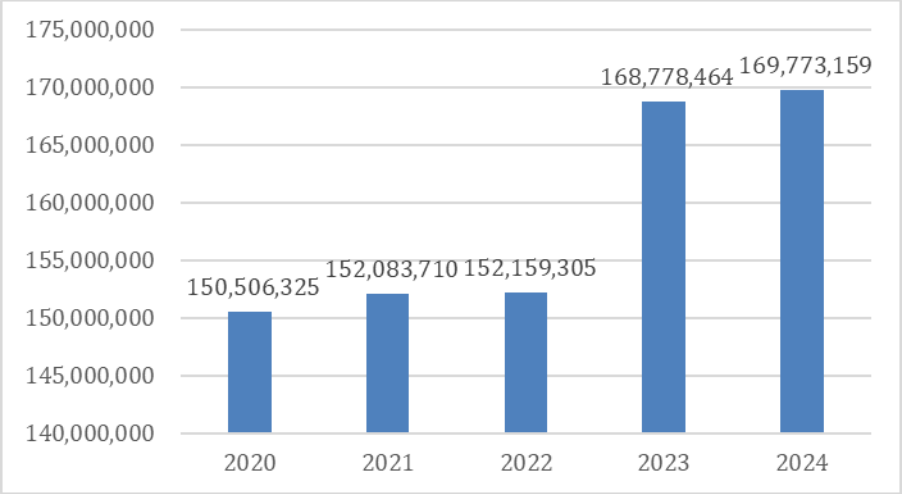
Evaluation of The Efficiency of Village Fund Allocation on Village Progress and IndependenceiIn Asahan Regency Using The Data Envelopment Analysis (DEA) Method

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ABSTRACT
This study aims to evaluate the efficiency of village fund allocation toward the progress and independence of villages in Asahan Regency, Indonesia. The background of this research arises from the issue of uneven development outcomes and low financial capacity in several villages despite receiving significant fiscal transfers. The study employs the Data Envelopment Analysis (DEA) method with a Variable Return to Scale (VRS) output-oriented model to measure the relative efficiency of 44 villages as Decision Making Units (DMUs). The input variables consist of village fund allocation and institutional capacity, while the output variables include the Village Development Index (IDM) and independence status. The results indicate that only about 20–25 percent of the villages operate efficiently, while the majority remain inefficient due to suboptimal operational scales and limited managerial competence. Most villages are under the Increasing Return to Scale (IRS) condition, suggesting that expanding resources and improving administrative capacity can significantly enhance performance. The findings highlight that efficient fund utilization is closely related to institutional strength and governance quality. Therefore, this study recommends strengthening village institutional capacity, improving financial transparency, and applying performance-based transfer mechanisms to optimize village fund management. These efforts are expected to support sustainable rural development and realize the goals of fiscal decentralization in Indonesia.
Keywords*: Village Fund, Efficiency, Data Envelopment Analysis, Fiscal Decentralization, Village Independence.*

INTRODUCTION

Village development constitutes one of the key priorities within Indonesia's national development framework, aimed at strengthening local economies, reducing regional disparities, and achieving sustainable rural independence. Under the fiscal decentralization policy, the Indonesian government has granted villages greater authority to independently manage their development budgets through the Village Fund Allocation (ADD) and the Village Fund (DD) schemes. This policy is expected to enhance the status of village progress and independence, which are measured using the Village Development Index (IDM).



Source : Ministry of Finance, 2024

Figure 1. 1 Allocation of Village Funds in Asahan Regency

Despite significant fiscal transfers to rural areas, the effectiveness of village fund utilization remains constrained by several challenges, including limited planning capacity, weak management accountability, and uneven development outcomes among villages. Ardiputra *et al* (2025) emphasize that the main obstacles in managing the Village Fund in Indonesia are low financial literacy among village officials, inadequate digital infrastructure, and limited public awareness regarding transparent and participatory governance. These issues highlight that larger budget allocations do not necessarily correspond to greater efficiency or improved levels of village independence. Asahan Regency was selected as the study area because it represents diverse village characteristics, ranging from independent and advanced to developing and underdeveloped. This heterogeneity enables comparative efficiency analysis under varying institutional and local capacity conditions. Moreover, Asahan Regency provides reliable and complete official data on the Village Development Index (IDM) and independence status, as recorded by the Ministry of Villages, Development of Disadvantaged Regions, and Transmigration (Kemendesa-PDTT). Forty-four villages were selected as Decision Making Units (DMUs) based on data completeness for both input variables (Village Fund allocation and institutional capacity) and output variables (Village Development Index and independence status). This comprehensive and purposive sampling approach minimizes bias and ensures a fair efficiency comparison among villages with different development categories.

Recapitulation analysis and previous studies show that there is a pattern of differences in allocation or realization of budget use between village status categories. Villages with status *self-sufficient*, *forward*or *flower* tend to show the realization of spending focused on productive programs and strengthening BUMDes so that effective allocation and relatively high budget use for economic development activities can be seen. Meanwhile, the village has the status of *Left behind* often receive special allocations or subsidies but their realization and impact vary due to limited planning and implementation capacity. These findings are in line with the literature on the role of institutional capacity and governance in determining the effectiveness of the Village Fund. Hartojo *et al* (2022) explained that with data on the status of village progress/independence in the recap of the

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Ministry of Villages-PDTT used in this study. Therefore, it is important to quantitatively test whether the amount of budget (input) is in line with the increase in IDM and self-sufficiency status (output) through the DEA approach.

Table 1. 1 **Status of Progress and Independence of Asahan Regency Village**

No.	Nama Desa	Status Kemajuan dan Kemandirian Desa	No.	Nama Desa	Status Kemajuan dan Kemandirian Desa
1	Air Joman Baru	MANDIRI	23	Silau Maraja	BERKEMBANG
2	Air Genting	MANDIRI	24	Ambalutu	BERKEMBANG
3	Hessa Air Genting	MANDIRI	25	Buntu Pane	BERKEMBANG
4	Air Teluk Hessa	MANDIRI	26	Aek Ledong	BERKEMBANG
5	Hessa Perlompongan	MANDIRI	27	Sei Kamah Baru	BERKEMBANG
6	Bunut Seberang	MANDIRI	28	Padang Mahondang	BERKEMBANG
7	Punggulan	MANDIRI	29	Manis	BERKEMBANG
8	Bunut Seberang	MAJU	30	Sei Lendir	BERKEMBANG
9	Subur	MAJU	31	Sei Kepayang Tengah	BERKEMBANG
10	Suka Damai	MAJU	32	Sei Kamah II	BERKEMBANG
11	Sei Silau Timur	MAJU	33	Sei Nadoras	BERKEMBANG
12	Silau Timur	MAJU	34	Sei Jawi-Jawi	BERKEMBANG
13	Air Joman Lama	MAJU	35	Perbangunan	BERKEMBANG
14	Aek Songsongan	MAJU	36	Sei Kepayang Tengah	BERKEMBANG
15	Simpang Empat	MAJU	37	Sei Kamah Baru	BERKEMBANG
16	Simpang Empat	MAJU	38	Sei Lendir	BERKEMBANG
17	Bangun Sari	BERKEMBANG	39	Sei Kamah I	BERKEMBANG
18	Sei Dua Hulu	BERKEMBANG	40	Padang Sari	BERKEMBANG
19	Rawang Lama	BERKEMBANG	41	Manis	BERKEMBANG
20	Sidodadi	BERKEMBANG	42	Sei Tempurung	TERTINGGAL
21	Piasa Ulu	BERKEMBANG	43	Sarang Helang	TERTINGGAL
22	Sei Nadoras	BERKEMBANG	44	Sei Sembilang	TERTINGGAL

Source: Ministry of Villages PDTT, 2024

Asahan Regency as one of the regions in North Sumatra Province also receives a large allocation of village funds every year. However, the level of progress and independence between villages in this district still shows disparities. This encourages the need for a more objective evaluation of the efficiency of the use of village funds, so that it can be known to what extent the funds are used optimally to encourage village progress and independence.

From these various studies, it can be concluded that the efficiency of village fund allocation is still the main challenge in efforts to realize sustainable and independent village development. Most previous research has highlighted the importance of governance, institutional capacity, and community involvement as determinants of the effectiveness of village funds. However, research that specifically measures the efficiency of village fund allocation on the status of village progress and independence with the DEA approach is still very limited, especially in the Asahan Regency area**.** Therefore, this study has a novelty value with a focus on evaluating how efficiently the use of village funds is in improving the Development Village Index (IDM) and the status of village independence. The results of the research are expected to be the basis for local governments in formulating a more effective and outcome-oriented village fund management strategy. In this research using a literature review which is The theory of fiscal decentralization, which is one of the main bases in the study of public policy and

regional development. According to (Oates, 2003) deep *Fiscal Federalism*, fiscal decentralization is the delegation of financial management authority from the central government to local governments so that public services can be adjusted to the needs of the local community. Through this mechanism, it is hoped that there will be an increase in allocative efficiency, because local governments better understand the potential and needs of their regions. (Musgrave, 1961) It also emphasized that the main functions of fiscal policy include allocation, distribution, and stabilization, where the allocation function is important in determining the effective use of public resources.

Economic efficiency is an important concept in the context of village development. According to Pareto in Mankiw (2020), efficiency occurs when resources are used optimally without lowering the welfare of other parties. Efficiency means the ability of the village government to make optimal use of local funds and resources to improve community welfare without waste (Pokhrel, 2024). This efficiency includes technical efficiency, i.e. the ability to produce maximum output from existing inputs, and allocative efficiency, i.e. the ability to allocate resources to activities with the highest economic benefits (Idialis *et al*., 2025)

The Village Fund Policy is a real implementation of the theory of fiscal decentralization as well as a means of realizing economic efficiency at the local level. The efficiency of the use of Village Funds can be measured through the quality of labor, the effectiveness of assistance, and the performance of BUMDes in managing village economic assets (Ela Melia Nisa (2022). When these three aspects are managed optimally, economic efficiency will be achieved and have an impact on increasing the income of the village community (Nuak *et al*., 2020). However, as reminded by (Lessmann, 2009) Without good supervision and institutional capacity, decentralization can actually lead to waste and ineffectiveness of the budget. Therefore, measuring the efficiency of the use of Village Funds is important to assess the success of fiscal decentralization in encouraging sustainable village development.

In line with this theory, several empirical studies show that the results of development between regions show considerable variation. Hartojo *et al* (2022) found that the implementation of the Village Fund significantly increased economic growth in disadvantaged villages, especially in Eastern Indonesia which grew by 156% compared to before the policy. These findings show that the Village Fund has a positive impact, but the level of effectiveness is highly dependent on local conditions and management capacity. Arifin *et al* (2020) also noted that although the number of Village-Owned Enterprises (BUMDes) has increased due to the Village Fund, the impact on employment opportunities is still limited because the use of BUMDes has not been optimal. This means that the efficiency of the allocation of Village Funds needs to be evaluated not only in terms of budget absorption, but also from the results produced for increasing the progress and independence of the village. Anam *et al* (2023) reinforcing these findings by showing that most villages have not been efficient in using allocated funds, especially due to the low capacity of village apparatus in planning and implementing development programs.

METHODOLOGY

To assess this efficiency, this study uses the Data Envelopment Analysis (DEA) method, which is a non-parametric approach that is able to measure the relative efficiency level of each decision-making unit (Decision Making Unit

(DMU) based on the inputs and outputs used. This approach has been widely used in public policy evaluation because of its ability to assess performance comparatively between units that have similar goals. On the other hand, DEA analysis is used to empirically evaluate the relative efficiency level between villages in Asahan Regency based on available data.

Various previous studies have been conducted to assess the effectiveness and efficiency of village fund management in Indonesia. Research by Arifin, B entitled *"Village Fund, Village-Owned Enterprises, and Employment: Evidence from Indonesia"* shows that village funds contribute to the increase in the number of *Village-Owned Enterprises (BUMDes*), but their impact on job creation is still limited. This indicates that even though village funds are well absorbed, they are not necessarily efficient in producing the expected economic output.

Study Hartojo *et al* (2022) In the article *"A Growing Light in the Lagging Region in Indonesia: The Impact of Village Fund on Rural Economic Growth"* It also provides empirical evidence that village funds have a positive effect on rural economic growth, especially in disadvantaged areas. Using the approach *Regression Discontinuity in Time (RDiT)*, this study found that villages in Eastern Indonesia grew faster than other regions after the village fund policy was enacted. These results show that the effectiveness of village funds is highly dependent on regional conditions and their implementation capacity. Moreover (Ardiputra et al., 2025) through research titled *"Optimizing Budget Policy in Village Fund Allocation (ADD): A Governance and Public Administration Perspective on Rural Development"* highlighting the governance aspect in the use of village funds. The results show that the effectiveness of *Village Fund Allocation (ADD)* It is greatly influenced by the factors of transparency, financial literacy of village officials, and community participation in budget supervision. These findings reinforce the view that efficiency depends not only on the size of funds, but also on the governance and accountability of program implementation.

Research conducted by Saharuddin (2024) Using the DEA models CCR and BCC It was also found that around 60% of villages are still inefficient in utilizing village funds, with an average efficiency value of 0.87. The main factors causing these inefficiencies include weak planning, low supervision, and less than optimal use of funds for the productive sector. Meanwhile, the study (Pal & Wahhaj, 2017) with title *"Fiscal Decentralisation, Local Institutions, and Public Good Provision: Evidence from Indonesia"* affirmed that fiscal decentralization has the potential to improve the provision of local public goods, especially if supported by strong local institutions. In this context, the effectiveness of the use of village funds will be higher if the community is actively involved and has a strong tradition of mutual cooperation in the development process.

Conceptually, the DEA has several main models developed by experts, among them the CCR model (Charnes, Cooper, and Rhodes, 1978) and the BCC model (Banker, Charnes, and Cooper, 1984).

- The CCR (Constant Return to Scale) model assumes that each DMU operates at a constant scale, meaning that the change in input will result in a change in output in equal proportions. This model measures Overall Technical Efficiency, which includes both pure technical efficiency and scale efficiency.
- The BCC (Variable Return to Scale) model was developed to accommodate conditions where there are differences in the scale of

operation between DMUs. This model measures Pure Technical Efficiency (PTE), which is pure technical efficiency that is not affected by the scale of production. In other words, BCC allows testing of Increasing Return to Scale (IRS), Constant Return to Scale (CRS), or Decreasing Return to Scale (DRS) conditions, thus providing more detailed information about the source of inefficiencies.

The two models are used in a complementary manner to provide a more comprehensive picture of village efficiency performance.

1. The CCR model is used to assess how efficient an overall village is in converting inputs into outputs without considering differences in scale capacity.
2. The BCC model is used to assess purely technical efficiency by taking into account variations in the scale of operations between villages.

From these various studies, it can be concluded that the efficiency of village fund allocation is still the main challenge in efforts to realize sustainable and independent village development. Most previous research has highlighted the importance of governance, institutional capacity, and community involvement as determinants of the effectiveness of village funds. However, research that specifically measures the efficiency of village fund allocation on the status of village progress and independence with the DEA approach is still very limited, especially in the Asahan Regency area**.** Therefore, this study has a novelty value with a focus on evaluating how efficiently the use of village funds is in improving the Development Village Index (IDM) and the status of village independence. The results of efficiency measurement with DEA are then interpreted and associated with theories and findings of previous research. For example, if there are villages with low efficiency scores even though they receive a large amount of Village Funds, this phenomenon can be explained through the perspective of institutional capacity, community participation, or the effectiveness of financial governance as stated in the literature. In this way, the analysis does not only stop at efficiency figures, but also provides an in-depth theory-based explanation of why there is a difference in efficiency levels between villages. The end result is not only in the form of measuring efficiency figures, but is also expected to be the basis for local governments in formulating a more effective and outcome-oriented village fund management strategy.

DEA analysis can be formulated through a number of different linear programming models, as formulated by Banker, Charnes, and Cooper (1984). This study specifically uses a DEA model with an output orientation that takes into account the variable conditions of returns to scale. The completion of the analysis is carried out through the following linear programming model:

Max ϕ_k

$$\sum_{j=1}^{n} \lambda_j \, y_{rj} \geq \phi_k \, y_{rk} \qquad r = 1,2, \ldots . s$$

$$\sum_{j=1}^{n} \lambda_j x_{ij} \leq \; x_{ik} \qquad i = 1,2 \ldots \ldots m$$

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

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$\lambda_j \geq 0, j$

The *formulation of the Max* ϕ_k model is used to measure the relative efficiency level of each *Decision Making Unit* (DMU). Suppose there is n as the number of decision-making units (DMU), which is the region or entity to be evaluated. Each DMU utilizes a certain number of m inputs and produces a certain number of s outputs.

The symbol x_{ik} denotes the number of i inputs used by the k DMU, while y_{rk} denotes the number of r outputs generated by the k DMU. Thus, x_{ik} describes the resources used (e.g., labor, capital, or land), while y_{rk} indicates performance or output results (such as production, public services, or regional income).
The variable λ_j is the weight or proportion of the contribution of other DMUs (j = 1, 2, ..., n) in the formation of *the efficiency frontier*. This weight is used to compare the DMU under evaluation (DMU_k) with the linear combination of other DMU, thus producing an efficient *frontier*.

The goal of this model is to maximize the ϕ_k, which is the efficiency score of the DMU to k. The value ϕ_k indicates how much of an increase in output would still be possible with the same input if the DMU operated efficiently.

- If $\phi_k = 1$, then DMUk is considered efficient, meaning that there is no further potential for improvement with the input used.
- If $\phi_k < 1$, then DMUk is categorized as inefficient, which means there is still room to increase output or optimize input usage to achieve full efficiency.

RESULTS AND DISCUSSION

Table 1. 2 **RTS Output-Oriented DEA Efficiency Results Analysis (VRS)**

VRS-OUTPUT Oriented DEA Efficiency Results:

	rank	theta	ref: 4	ref: 3	ref: 11	ref: 8	ref: 23	ref: 19	ref: 10	ref: 36
dmu:4	20	.838988	.	.	.	.	.	.	.	.
dmu:3	4	.988533	.	.	.	.	.	.	.	.
dmu:11	2	1	.	.	.	.	.	.	.	.
dmu:8	18	.852095	.	.	.	.	.	.	.	.
dmu:23	38	.73543	.	.	.	.	.	.	.	.
dmu:19	37	.76452	.	.	.	.	.	.	.	.
dmu:10	8	.922365	.	.	.	.	.	.	.	.
dmu:36	14	.888742	.	.	.	.	.	.	.	.
dmu:37	10	.909327	.	.	.	.	.	.	.	.
dmu:31	6	.944556	.	.	.	.	.	.	.	.
dmu:32	16	.854513	.	.	.	.	.	.	.	.
dmu:18	39	.721835	.	.	.	.	.	.	.	.
dmu:30	24	.812271	.	.	.	.	.	.	.	.
dmu:6	1	1	.	.	.	.	.	.	.	.
dmu:33	22	.821861	.	.	.	.	.	.	.	.
dmu:7	23	.812792	.	.	.	.	.	.	.	.
dmu:34	6	.944556	.	.	.	.	.	.	.	.
dmu:12	3	.995508	.	.	.	.	.	.	.	.
dmu:10	8	.922365	.	.	.	.	.	.	.	.
dmu:5	11	.901289	.	.	.	.	.	.	.	.
dmu:9	33	.793002	.	.	.	.	.	.	.	.
dmu:1	26	.810454	.	.	.	.	.	.	.	.
dmu:2	15	.886984	.	.	.	.	.	.	.	.
dmu:25	27	.802554	.	.	.	.	.	.	.	.
dmu:15	21	.831659	.	.	.	.	.	.	.	.
dmu:13	31	.795248	.	.	.	.	.	.	.	.
dmu:35	12	.893604	.	.	.	.	.	.	.	.
dmu:29	35	.775239	.	.	.	.	.	.	.	.
dmu:28	40	.719354	.	.	.	.	.	.	.	.
dmu:27	19	.839288	.	.	.	.	.	.	.	.
dmu:30	24	.812271	.	.	.	.	.	.	.	.
dmu:24	30	.797404	.	.	.	.	.	.	.	.
dmu:17	34	.780471	.	.	.	.	.	.	.	.
dmu:28	40	.719354	.	.	.	.	.	.	.	.
dmu:25	27	.802554	.	.	.	.	.	.	.	.
dmu:29	35	.775239	.	.	.	.	.	.	.	.
dmu:26	17	.853435	.	.	.	.	.	.	.	.
dmu:16	29	.798613	.	.	.	.	.	.	.	.
dmu:35	12	.893604	.	.	.	.	.	.	.	.
dmu:13	31	.795248	.	.	.	.	.	.	.	.
dmu:14	5	.977302	.	.	.	.	.	.	.	.
dmu:22	42	.696356	.	.	.	.	.	.	.	.
dmu:20	44	.683549	.	.	.	.	.	.	.	.
dmu:21	43	.690507	.	.	.	.	.	.	.	.

Source : Calculation Analysis Through STATA

The description of the relative efficiency level of each Decision Making Unit (DMU) was obtained based on the findings of the analysis using the Data Envelope Analysis (DEA) method with the VRS-Output Oriented approach. The capacity of each DMU to optimize the output generated from the various inputs available is highlighted by this model. The results show that some DMUs, particularly DMUs 6, 12, and 23, have achieved the perfect efficiency level indicated by a theta value of 1. The results of the use of inputs and outputs are

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optimal because these values show that the three units function at the frontier efficiency limit. Because these units have demonstrated their ability to manage resources effectively, they can serve as a reference or benchmark for other DMUs looking to improve their operational efficiency. In addition, a number of DMUs, including DMU 37 (0.999327), DMU 36 (0.888742), and DMU 4 (0.838988), show high efficiency but not flawless. This figure shows that despite the good performance, there is still an opportunity to increase output to achieve maximum efficiency. To achieve maximum output, these units require only minor adjustments to their input management. In addition, there are DMU groups with moderate efficiency levels, such as DMU 2 (0.886984), DMU 5 (0.921889), and DMU 10 (0.922365). The efficiency value in this range illustrates that the DMU is already operating quite well, but can still improve performance, especially through output optimization. By making adjustments to production or distribution strategies, these units have the potential to move towards perfect efficiency (Slavinskaite et al., 2020).

A number of other units, including DMU 1 (0.818454), DMU 9 (0.790202), and DMU 13 (0.795248), are included in the low to medium efficiency category. There is still an imbalance between the number of inputs used and the output produced when the efficiency value is less than 0.8. To reduce waste and increase output, DMUs in this category must assess labor productivity, resource utilization, and operational tactics. In addition, of all the units, DMU 20 (0.683549) and DMU 21 (0.698507) have the lowest efficiency values. This condition shows that the inputs used are not yet in their best condition, resulting in incomparable results. In-depth evaluation of input components, such as operational costs, labor, and production facilities, is needed in order to achieve a significant increase in efficiency (Lessmann, 2009).

The DMU that serves as a comparison or reference for units that are not yet efficient is displayed in the reference column (ref). DMU 4 for example refers to DMU 6, 23, and 11. This shows that the three units can be used as a model for DMU 4 to improve its performance because it has an effective input and output combination pattern. Based on the findings of the analysis, the three DMUs are actually very efficient, while most of them function at a fairly high level. However, some units still show efficiency below 0.8 which indicates the need for improved resource management and production strategies to achieve optimal efficiency as a DMU with a perfect efficiency value.

Table 1. 3 ***RTS Output-Oriented DEA Efficiency Results Analysis (VRS)***

	CRS_TE	VRS_TE	NIRS_TE	SCALE	RTS
dmu:4	0.697032	0.838988	0.839217	0.830801	1.000000
dmu:3	0.722275	0.988533	0.996489	0.730654	-1.000000
dmu:11	0.834844	1.000000	1.000000	0.834844	-1.000000
dmu:8	0.799864	0.852095	0.852095	0.938702	1.000000
dmu:23	0.493016	0.735430	0.745672	0.670379	1.000000
dmu:19	0.705326	0.764520	0.764520	0.922574	1.000000
dmu:10	0.839443	0.922365	0.922365	0.910098	1.000000
dmu:36	0.786243	0.888742	0.888742	0.884670	1.000000
dmu:37	0.666783	0.909327	0.916435	0.733271	1.000000
dmu:31	0.799166	0.944556	0.944556	0.846076	1.000000
dmu:32	0.774603	0.854513	0.854513	0.906485	1.000000
dmu:18	0.503330	0.721835	0.729896	0.697293	1.000000
dmu:30	0.579605	0.812271	0.820075	0.713562	1.000000
dmu:6	1.000000	1.000000	1.000000	1.000000	0.000000
dmu:33	0.769843	0.821861	0.821861	0.936707	1.000000
dmu:7	0.808595	0.812792	0.812792	0.994837	1.000000
dmu:34	0.799166	0.944556	0.944556	0.846076	1.000000
dmu:12	0.818291	0.995508	0.996380	0.821984	-1.000000
dmu:10	0.839443	0.922365	0.922365	0.910098	1.000000
dmu:5	0.698821	0.901289	0.905177	0.775358	1.000000
dmu:9	0.686137	0.793002	0.793002	0.865240	1.000000
dmu:1	0.683007	0.810454	0.810454	0.842746	1.000000
dmu:2	0.631389	0.886984	0.895649	0.711838	1.000000
dmu:25	0.704318	0.802554	0.802554	0.877595	1.000000
dmu:15	0.414789	0.831659	1.000000	0.498749	1.000000
dmu:13	0.540510	0.795248	0.805544	0.679675	1.000000
dmu:35	0.483705	0.893604	0.989555	0.541297	1.000000
dmu:29	0.739267	0.775239	0.775239	0.953599	1.000000
dmu:28	0.619727	0.719354	0.719354	0.861505	1.000000
dmu:27	0.795583	0.839288	0.839288	0.947926	1.000000
dmu:30	0.579605	0.812271	0.820075	0.713562	1.000000
dmu:24	0.704061	0.797404	0.797404	0.882942	1.000000
dmu:17	0.631006	0.780471	0.781897	0.808495	1.000000
dmu:28	0.619727	0.719354	0.719354	0.861505	1.000000
dmu:25	0.704318	0.802554	0.802554	0.877595	1.000000
dmu:29	0.739267	0.775239	0.775239	0.953599	1.000000
dmu:26	0.853435	0.853435	0.853435	1.000000	0.000000
dmu:16	0.784986	0.798613	0.798613	0.982936	1.000000
dmu:35	0.483705	0.893604	0.989555	0.541297	1.000000
dmu:13	0.540510	0.795248	0.805544	0.679675	1.000000
dmu:14	0.580539	0.977302	1.000000	0.594022	-1.000000
dmu:22	0.622405	0.696356	0.696356	0.893803	1.000000
dmu:20	0.588251	0.683549	0.683549	0.860584	1.000000
dmu:21	0.443013	0.690507	0.702353	0.641576	1.000000

Source : Calculation Analysis Through STATA

From the above description, the efficiency level of each DMU or Decision Making Unit in three concepts of positive variation approach to output/input, namely Constant Return to Scale (CRS), Variable Return to Scale (VRS) and Non-Increasing Return to Scale (NIRS). Values are within 0 to 1, where 1 is the full value which means the DMU has been operating efficiently, while otherwise the value <1 indicates a lack of efficiency. The efficiency comparison between CRS and VRS is used to analyze that the DMU is present at the point of pure or the operational scale characteristic in operating the DMU. Efficiency evaluations that take into account the difference between constant scale (CRS) and variable

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scale (VRS) are of course important to understand whether a unit is already operating at optimal scale. An efficient unit under the VRS but inefficient in the CRS indicates an operational capacity issue, not a technical weakness, thus requiring a scale adjustment (Slavinskaite et al., 2020).

There are several DMUs, for example DMU 6, and DMU 26, that have CRS, VRS, and NIRS values = 1.000000. So, this DMU can be classified as a truly efficient DMU and this DMU already exists on an optimal operational scale. On the other hand, there are DMUs, e.g. DMU 18 , which show low efficiency, since the values LCS = 0.503330 and SVRS= 0.721835; Scale = 0.697293. Therefore, its efficiency is low, mainly due to the problem of operational scale, since its VRS factor value of 0.721835 is much more than the CRS factor of the VRS region. The same action can be seen from DMU 30 (CRS = 0.579605; VRS = 0.812271. This means that, technically, DMUs are almost efficient, but they are not yet at an ideal scale. For many DMUs, a scale value of less than one indicates inefficiency. For example, DMU 2 has a CRS = 0.631389 and a Scale = 0.711388, which indicates that the DMU is in a condition of a declining yield scale (DRS).

It is necessary to reduce the scale of operations to become efficient. In contrast, DMU 3 and DMU 5 are in the grow-yield scale (IRS) category, which suggests that efficiency can be improved by expanding operational scale. Therefore, it is necessary to reduce the size to determine the wasted resources. In the context of fiscal decentralization, some local institutions actually experience a decrease in efficiency when their operational scale is too large. This condition reflects decreasing returns to scale, where the additional inputs are no longer proportional to the output produced, so that capacity reduction is a strategy to avoid wasting resources (Pal & Wahhaj, 2017).

Overall, these results suggest that many DMUs still need to modify their scale of operation, even if certain units are efficient. Although the DMU with a VRS of around 1 and a low CRS shows a fairly good technical dimension, the main problem is that the size of the business does not match its maximum capacity. Policymakers can use this useful information to decide how to improve efficiency, in particular by scaling operations closer to the maximum capacity of each DMU. Deep Hartojo *et al* (2022) emphasized that the optimization of public resources through village funds has a positive impact on local economic growth only if management is carried out according to the right capacity. In other words, the efficiency of development is not only determined by technical quality, but also by the suitability of the operational scale with the potential of the region.

Table 1. 4 DEA Model Analysis Results on 44 DMUs

VRS Frontier:

	dmu_id	INPUT1	OUTPUT1	dmu	CRS_TE	VRS_TE	SCALE	RTS
1.	Air Joman Baru	991,971	4.9284722	Air Joman Baru	0.697032	0.838988	0.830801	irs
2.	Air Genting	1127935	5.8069444	Air Genting	0.722275	0.988533	0.730654	drs
3.	Hessa Air Genting	987,166	5.8743056	Hessa Air Genting	0.834844	1.000000	0.834844	drs
4.	Bangun Sari	847,754	4.8333333	Bangun Sari	0.799864	0.852095	0.938702	irs
5.	Sei Dua Hulu	1229350	4.3201389	Sei Dua Hulu	0.493016	0.735430	0.670379	irs
6.	Rawang Lama	866,763	4.3576389	Rawang Lama	0.705326	0.764520	0.922574	irs
7.	Bunut Seberang	882,062	5.2777778	Bunut Seberang	0.839443	0.922365	0.910098	irs
8.	Subur	914,980	5.1277778	Subur	0.786243	0.888742	0.884670	irs
9.	Suka Damai	1123910	5.3416667	Suka Damai	0.666783	0.909327	0.733271	irs
10.	Sei Silau Timur	969,917	5.525	Sei Silau Timur	0.799166	0.944556	0.846076	irs
11.	Sidodadi	886,594	4.8951389	Sidodadi	0.774603	0.854513	0.906485	irs
12.	Piasa Ulu	1181900	4.2402778	Piasa Ulu	0.503330	0.721835	0.697293	irs
13.	Sei Nadoras	1154953	4.7715278	Sei Nadoras	0.579605	0.812271	0.713562	irs
14.	Air Teluk Hessa	782,529	5.5777778	Air Teluk Hessa	1.000000	1.000000	1.000000	-
15.	Silau Maraja	850,061	4.6645833	Silau Maraja	0.769843	0.821861	0.936707	irs
16.	Ambalutu	787,633	4.5395833	Ambalutu	0.808595	0.812792	0.994837	irs
17.	Silau Timur	969,917	5.525	Silau Timur	0.799166	0.944556	0.846076	irs
18.	Hessa Perlompongan	1002611	5.8479167	Hessa Perlompongan	0.818291	0.995508	0.821984	drs
19.	Bunut Seberang	882,062	5.2777778	Bunut Seberang	0.839443	0.922365	0.910098	irs
20.	Air Joman Lama	1062903	5.2944444	Air Joman Lama	0.698821	0.901289	0.775358	irs
21.	Buntu Pane	941,837	4.60625	Buntu Pane	0.686137	0.793002	0.865240	irs
22.	Aek Ledong	974,968	4.7465278	Aek Ledong	0.683007	0.810454	0.842746	irs
23.	Aek Songsongan	1157749	5.2104167	Aek Songsongan	0.631389	0.886984	0.711838	irs
24.	Sei Kamah Baru	924,580	4.6416667	Sei Kamah Baru	0.704318	0.802554	0.877595	irs
25.	Padang Mahondang	1652395	4.8854167	Padang Mahondang	0.414789	0.831659	0.498749	irs
26.	Manis	1212536	4.6715278	Manis	0.540510	0.795248	0.679675	irs
27.	Simpang Empat	1522511	5.2493056	Simpang Empat	0.483705	0.893604	0.541297	irs
28.	Sei Lendir	830,923	4.3784722	Sei Lendir	0.739267	0.775239	0.953599	irs
29.	Sei Kepayang Tengah	947,182	4.1840278	Sei Kepayang Tengah	0.619727	0.719354	0.861505	irs
30.	Sei Kamah II	837,253	4.7479167	Sei Kamah II	0.795583	0.839288	0.947926	irs
31.	Sei Nadoras	1154953	4.7715278	Sei Nadoras	0.579605	0.812271	0.713562	irs
32.	Sei Jawi-Jawi	917,306	4.6034722	Sei Jawi-Jawi	0.704061	0.797404	0.882942	irs
33.	Perbangunan	1019339	4.5847222	Perbangunan	0.631006	0.780471	0.808495	irs
34.	Sei Kepayang Tengah	947,182	4.1840278	Sei Kepayang Tengah	0.619727	0.719354	0.861505	irs
35.	Sei Kamah Baru	924,580	4.6416667	Sei Kamah Baru	0.704318	0.802554	0.877595	irs
36.	Sei Lendir	830,923	4.3784722	Sei Lendir	0.739267	0.775239	0.953599	irs
37.	Sei Kamah I	765,087	4.6541667	Sei Kamah I	0.853435	0.853435	1.000000	-
38.	Padang Sari	799,656	4.4743056	Padang Sari	0.784986	0.798613	0.982936	irs
39.	Simpang Empat	1522511	5.2493056	Simpang Empat	0.483705	0.893604	0.541297	irs
40.	Manis	1212536	4.6715278	Manis	0.540510	0.795248	0.679675	irs
41.	PUNGGULAN	1387374	5.7409722	PUNGGULAN	0.580539	0.977302	0.594022	drs
42.	SEI TEMPURUNG	902,878	4.0055556	SEI TEMPURUNG	0.622405	0.696356	0.893803	irs
43.	SARANG HELANG	948,508	3.9770833	SARANG HELANG	0.588251	0.683549	0.860584	irs
44.	SEI SEMBILANG	1284540	4.05625	SEI SEMBILANG	0.443013	0.690507	0.641576	irs

Source : Calculation Analysis Through STATA

Based on the results of the Data Envelopment Analysis (DEA) analysis on

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the efficiency of the allocation of Village Funds in Asahan Regency, the results were obtained that the level of technical efficiency between villages varied. Of the total 44 villages (DMUs) analyzed, only a small fraction achieved perfect efficiency values (VRS_TE = 1,000). This shows that these villages have been able to manage the Village Fund optimally, where inputs in the form of fund allocation and institutional capacity have succeeded in producing outputs in the form of increasing the status of progress and village independence effectively (Slavinskaite et al., 2020).

For example, some villages, such as Hessa Water Genting and Hessa Bay Water, obtained a score of VRS_TE = 1,000, which means that the village falls into the category of perfectly efficient. The inputs and outputs used in the model have been balanced and are able to produce maximum impact on village development performance Hartojo *et al* (2022). However, most other villages still show an efficiency value below 1, which indicates inefficiencies in the management of the Village Fund. For example, Padang Mahodang Village has an efficiency value of VRS of 0.83 and CRS of 0.41, indicating that the use of inputs has not been fully optimized to produce maximum output.

In aggregate, only about 20–25% of villages are technically efficient (VRS_TE = 1), while around 75–80% of villages are still in an inefficient condition (VRS_TE < 1). Villages that are not efficient generally have low CRS_TE values, indicating the influence of production scales that are not optimal in managing the Village Fund. Based on the Return to Scale (RTS) value, most villages operate under the condition of Increasing Return to Scale (IRS), meaning that an increase in inputs such as the amount of Village Fund or human resource capacity has the potential to increase output even more. In contrast, some villages operate on Decreasing Return to Scale (DRS) conditions, where increased inputs no longer provide results proportional to output.

These results show that the allocation of Village Funds in Asahan Regency has not been fully efficient in supporting the progress and independence of the village. Therefore, there is a need for policy optimization through increasing the capacity of village apparatus, program planning based on real community needs, and strengthening local economic innovation. Thus, the Village Fund policy can be more aligned with the principle of fiscal decentralization, which is to encourage equitable development and fiscal independence at the village level in a sustainable manner (Pasaribu *et al*., 2024).

The results of the Data Envelopment Analysis (DEA) evaluation showed that there was a real difference in village efficiency in Asahan Regency. Only about 20–25% of the 44 villages examined achieved perfect technical efficiency (VRS_TE = 1), and most are still inefficient. These results show that the ability of the Village Fund to support the improvement of the Village Development Index (IDM) and the status of village independence is still not running optimally. The extent to which the concept of fiscal decentralization has been successfully implemented at the village level is reflected in the efficiency of this variable. Fiscal decentralization seeks to increase allocative efficiency by giving local governments the freedom to choose regional development priorities, in accordance with the theory of fiscal federalism. However, in practice, not all villages are able to manage the Village Fund efficiently due to limited institutional capacity and financial governance (Altunbaş & Thornton, 2012; Vo, 2010)(20). The DEA results show that most villages are still operating on Increasing Return to Scale (IRS), which means that increased inputs such as Village Funds and

human resource capacity can still increase development output by a greater proportion (Ding et al., 2024).

In contrast, some villages showed Decreasing Return to Scale (DRS) conditions, indicating that increased funds no longer provided results proportional to output. This phenomenon reflects low managerial capacity, weak community participation, and unproductive use of Village Funds (Martinez-Vazquez & McNab, 2003). This condition is in line with studies (Kis-Katos & Sjahrir, 2017) which highlights that without strong regional governance and accountability, fiscal decentralization does not necessarily result in increased public efficiency. The conclusion that operational scale factors and institutional capacity have a significant effect on village fiscal efficiency is strengthened by the comparison of VRS and CRS in DEA results. Villages with low CRS efficiency and high VRS show managerial effectiveness, but are not at the best economic level. This shows how important it is to increase the institutional capacity and technical capabilities of village officials in planning and implementing development initiatives (Udeagha & Ngepah, 2023). From a development perspective, the results of this DEA show that villages with high efficiency values tend to experience faster IDM increases. Efficient villages usually utilize Village Funds for productive activities such as the establishment of BUMDes, local economic empowerment, and the improvement of basic public services.

Research (Arifin et al., 2020) and Hartojo *et al* (2022) This shows that village economic growth and poverty alleviation are greatly influenced by village funds allocated for community empowerment and productive economic activities. In contrast, inefficient villages often spend village funds on unproductive efforts such as temporary physical improvements that do not directly increase local revenues. These findings are in line with research (Watts et al., 2019) and (Pal & Wahhaj, 2017) which highlights that village fiscal transfers are often directed towards symbolic projects rather than sustainable productive activities.

Institutionally, the level of efficiency in the use of Village Funds is greatly influenced by transparency and coordination between levels of government. Study (Jia et al., 2020) shows how fiscal decentralization can improve regional economic growth and public service performance when combined with innovation and efficient monitoring systems. Effective villages in Asahan Regency usually have open financial reporting procedures and strong ties with local governments. Several policy actions are suggested to improve efficiency and align with the objectives of fiscal decentralization: (1) improving the managerial and institutional capabilities of village officials; (2) encouraging the use of Village Funds for innovative and productive sectors; (3) implementing an effective performance-based fund transfer system for villages; and (4) strengthen the fiscal monitoring and evaluation system based on DEA data. With this strategy, the Village Fund can play a more role as a fiscal decentralization instrument that encourages independence, equitable development, and sustainable economic growth at the village level.

CONCLUSION

This study aims to evaluate the level of efficiency of the Village Fund allocation to the progress and independence of villages in Asahan Regency using *the Data Envelopment Analysis (DEA)* method of the *output-oriented Variable Return to Scale (VRS)* model . The results of the analysis show that the level of efficiency between villages still varies. Only about 20-25 percent of villages are

technically efficient, while most villages have not reached the optimal level of efficiency. These inefficiencies are generally caused by disproportionate operational scales, limited capacity of village apparatus, and low effectiveness in the use of Village Funds for the productive sector. Most villages are in *the condition of Increasing Return to Scale (IRS),* which indicates that increasing the capacity of human resources and institutions still has the potential to produce greater development output. These results emphasize that the effectiveness of the Village Fund does not only depend on the amount of funds received, but also on the quality of governance, planning ability, and transparency in village financial management. Efficient villages are generally able to utilize Village Funds for productive activities such as strengthening BUMDes, developing the local economy, and improving basic public services.

In terms of policy, strategic steps are needed in the form of increasing village managerial and institutional capacity, implementing a performance-based fund allocation system, and strengthening sustainable monitoring and evaluation mechanisms. Transparency and community participation also need to be increased so that the Village Fund really has a real impact on economic independence and equitable development. The next research is suggested to expand the analysis model to include socio-economic variables such as poverty reduction, income increase, and community participation, as well as conduct a comparative study between regions to obtain a more comprehensive picture of the efficiency of Village Funds in Indonesia.

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