



Analysis of Physical Special Allocation Fund Management Efficiency at the Public Works and Spatial Planning Agency of Buleleng Regency

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ABSTRACT

This study evaluates the technical efficiency of the Physical Special Allocation Fund (DAK Fisik) management in road infrastructure projects implemented by the Public Works and Spatial Planning Agency of Buleleng Regency. The study applies a quantitative approach using Data Envelopment Analysis (DEA) with a Constant Returns to Scale (CRS) input-oriented model. Twelve road infrastructure projects financed by DAK Fisik during 2021–2025 were analyzed as Decision Making Units (DMUs). The input variables consisted of DAK Fisik budget allocation and planned road length, while the outputs were realized road length and physical completion rate. The results show that only three projects (25%) were technically efficient, whereas nine projects (75%) remained inefficient indicating substantial opportunities to improve resource allocation and project planning for more efficient public infrastructure management.

INTRODUCTION

Road infrastructure plays a fundamental role in regional development by facilitating community mobility, improving the distribution of goods and services, strengthening interregional connectivity, and supporting regional competitiveness. Adequate road infrastructure also enhances access to public services and stimulates local economic growth. Within Indonesia's fiscal decentralization framework, infrastructure development is supported by the Special Allocation Fund (Dana Alokasi Khusus/DAK) Fisik, a transfer from the State Budget (APBN) to local governments for financing physical infrastructure that aligns with national development priorities. The implementation of DAK Fisik reflects the principles of fiscal equalization and fiscal federalism, which seek to reduce fiscal disparities and improve the efficiency of public resource allocation across regions (Oates, 1972; Widodo, 2022). Road infrastructure has consequently become one of the strategic sectors financed through DAK Fisik because many local governments experience fiscal constraints in financing infrastructure solely through regional budgets.

The strategic importance of DAK Fisik is demonstrated by its substantial national allocation. The Ministry of Finance reported that funding for the road transportation sector reached approximately IDR 42.8 trillion in 2025. Large budget allocations, however, do not necessarily guarantee efficient implementation or optimal infrastructure outcomes. National DAK Fisik absorption has consistently remained around 70–80% annually, indicating persistent challenges in planning, implementation, and budget utilization at the local government level. Public sector performance therefore requires evaluation not only in terms of financial realization but also in terms of how efficiently public resources are transformed into development outputs. Farrell (1957) argued that efficiency is achieved when a production unit generates the maximum possible output from a given level of input. This concept later became the theoretical foundation of the Production Frontier Theory and the Data Envelopment Analysis (DEA) model introduced by Charnes et al. (1978).

Buleleng Regency in Bali Province provides an appropriate case for evaluating the efficiency of DAK Fisik because of its diverse geographical characteristics, extending from coastal to mountainous areas. Reliable road infrastructure is essential for supporting tourism, facilitating logistics, improving accessibility, and connecting economic activities throughout the region. Despite continuous investment in road development, infrastructure conditions remain problematic. The Public Works and Spatial Planning Office (PUTR) reported that Buleleng possesses approximately 949.82 km of roads, of which around 233.52 km remain in poor or unstable condition, while approximately 25 km of damaged roads were scheduled for rehabilitation in the subsequent fiscal year. These conditions indicate that infrastructure needs continue to exceed realized development outcomes, highlighting the importance of evaluating the efficiency of infrastructure investment rather than focusing solely on expenditure levels.

Road projects financed through DAK Fisik in Buleleng Regency also exhibited considerable variation during 2021–2025. Four DAK-funded projects

were implemented in 2021, five in 2022, none in 2023, three in 2024, and none again in 2025. Such fluctuations suggest inconsistencies in the utilization of DAK

Fisik for road infrastructure development. Evaluation based solely on allocated budgets or project numbers cannot adequately determine whether public resources have produced optimal physical outcomes. Performance assessment should therefore examine the relationship between inputs, including DAK Fisik allocation and planned road length, and outputs, including realized road length and physical completion rates. Such an approach is consistent with the production frontier concept, which evaluates whether comparable units have transformed available resources into maximum achievable outputs (Farrell, 1957).

Data Envelopment Analysis (DEA) offers an appropriate framework for measuring relative efficiency because it simultaneously accommodates multiple inputs and outputs without requiring assumptions regarding the functional relationship between variables (Cooper et al., 2006). DEA constructs an empirical efficiency frontier from observed data and compares each Decision Making Unit (DMU) with the best-performing units (Thanassoulis, 2018). Projects positioned on the frontier are classified as efficient, whereas those below the frontier are considered relatively inefficient and receive improvement targets (Charnes et al., 1978). The flexibility of DEA has led to its widespread application in evaluating efficiency across education, healthcare, public expenditure, and construction sectors (Parwoto et al., 2021; Yanti & Kustiani, 2024; Rahmi & Zulkifli, 2025; Rahmawati & Muhsyaf, 2025; Arsyad & Wibowo, 2015).

Previous studies have demonstrated the usefulness of DEA in measuring public sector efficiency; however, important research gaps remain. Existing studies concerning DAK Fisik primarily examine implementation effectiveness, budget realization, or infrastructure outcomes rather than technical efficiency at the project level (Wahyudi, 2021; Pambudi, 2024). Research focusing on road infrastructure has generally discussed the contribution of DAK to road quality improvement without employing DEA as an analytical tool (Digdowiseiso & Lukman, 2023). Furthermore, most DEA studies have adopted provinces, municipalities, schools, hospitals, or public institutions as Decision Making Units, whereas individual road development projects have rarely been treated as DMUs. Empirical evidence regarding the efficiency of DAK Fisik management in Buleleng Regency also remains limited despite the strategic importance of the region for tourism and regional connectivity.

This study aims to evaluate the efficiency of DAK Fisik management in road infrastructure development projects in Buleleng Regency using the Data Envelopment Analysis (DEA) approach under the Constant Returns to Scale (CRS) assumption. The analysis employs DAK Fisik budget allocation and planned road length as input variables, while realized road length and physical completion percentage are treated as output variables. Each DAK-funded road

project is considered an independent Decision Making Unit to identify efficient and inefficient projects, establish efficiency benchmarks, and provide recommendations for improving public resource allocation and infrastructure management.

The findings are expected to contribute to the literature on public sector efficiency while providing practical evidence to support more effective management of DAK Fisik in regional road infrastructure development.

LITERATURE REVIEW

Efficiency Theory

Efficiency Theory proposed by Farrell (1957) explains that the efficiency of a production unit is determined by its ability to produce the maximum possible output from a given set of inputs. Farrell distinguished technical efficiency from allocative efficiency, where technical efficiency reflects the capability of transforming inputs into outputs without waste, whereas allocative efficiency considers the optimal combination of inputs according to their prices. The production frontier introduced by Farrell serves as the benchmark for identifying efficient and inefficient units. Decision-making units (DMUs) operating on the frontier are considered fully efficient, while those below the frontier are regarded as inefficient because they fail to maximize output with available resources (Farrell, 1957).

The efficiency frontier concept subsequently became the theoretical foundation of Data Envelopment Analysis (DEA), developed by Charnes et al. (1978). DEA constructs an empirical production frontier based on observed data and evaluates the relative efficiency of homogeneous decision-making units. Since DEA does not require assumptions regarding production functions or statistical distributions, it has become one of the most widely used approaches for measuring efficiency in the public sector (Cooper et al., 2006; Thanassoulis, 2018).

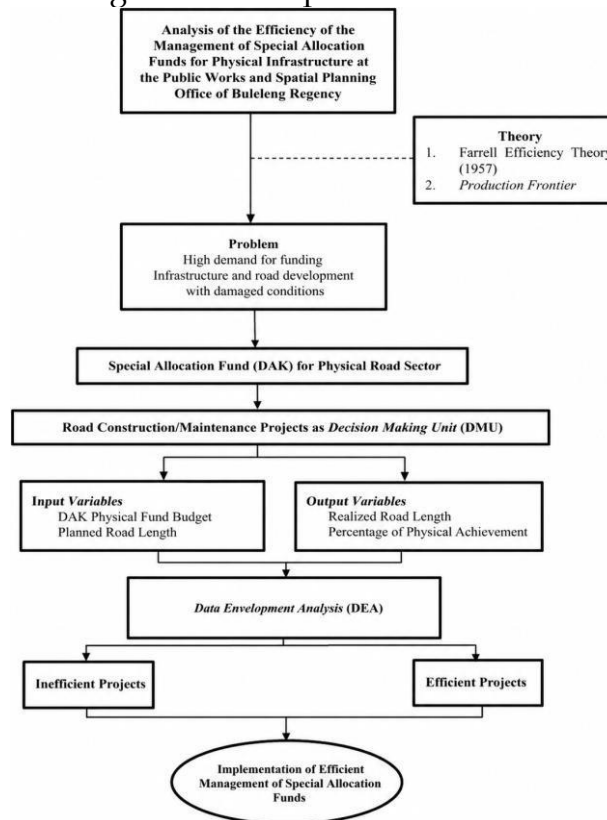
Several previous studies support the application of DEA in evaluating public sector efficiency. Parwoto et al. (2021) demonstrated that DEA effectively measures the relative efficiency of educational institutions. Rahmi and Zulkifli (2025) and Yanti and Kustiani (2024) applied DEA to evaluate health expenditure efficiency and found that many regional governments had not yet achieved optimal efficiency. Rahmawati and Muhsyaf (2025) further confirmed the applicability of DEA for assessing government expenditure efficiency in both education and health sectors using the CRS model. These findings indicate that DEA provides an appropriate analytical framework for evaluating government-funded development programs.

Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a non-parametric linear programming technique developed by Charnes et al. (1978) to evaluate the relative efficiency of comparable decision-making units using multiple inputs and outputs simultaneously. DEA identifies the efficiency frontier by comparing each DMU with the best-performing units in the sample. Units located on the frontier obtain an efficiency score equal to one, whereas units below the frontier receive scores lower than one and become candidates for performance improvement (Charnes et al., 1978).

Compared with parametric approaches such as the Stochastic Frontier Analysis (SFA), DEA offers greater flexibility because it does not require assumptions regarding production functions or error distributions (Cooper et al., 2006). This characteristic makes DEA particularly suitable for evaluating public sector organizations where production processes are difficult to represent using predefined functional forms (Thanassoulis, 2018). Previous studies have successfully implemented DEA in construction (Arsyad & Wibowo, 2015), infrastructure planning (Israwana et al., 2016), public expenditure (Rahmawati & Muhsyaf, 2025), and regional government performance (Rahmi & Zulkifli, 2025). Conceptual Framework.

Figure 1. Conceptual Framework



METHODOLOGY

This study employed a quantitative descriptive approach to evaluate the technical efficiency of the Special Allocation Fund (Dana Alokasi Khusus/DAK) Fisik in road infrastructure development projects in Buleleng Regency, Bali, Indonesia. Secondary data were collected from the Public Works and Spatial Planning Office (PUTR) of Buleleng Regency and supporting documents, including project planning reports, budget realization reports, and physical implementation records for the 2021–2025 period. The unit of analysis consisted of 12 road construction and maintenance projects financed by DAK Fisik, with each project treated as an independent Decision Making Unit (DMU). Only projects with complete information on budget allocation, planned road length, realized road length, and physical completion rate were included in the analysis. The efficiency assessment was conducted using Data Envelopment Analysis (DEA), a non-parametric linear programming technique widely applied to evaluate the relative efficiency of homogeneous decision-making units with

multiple inputs and outputs (Coelli, 1996; Camanho et al., 2024). The analysis adopted the Constant Returns to Scale (CRS) model with an input-oriented approach because the study focused on optimizing resource utilization in public infrastructure projects. Two input variables were employed, namely DAK Fisik budget allocation (IDR) and planned road length (km), while the output variables comprised realized road length (km) and the percentage of physical completion (%). The DEA model estimates technical efficiency by comparing the weighted ratio of outputs to inputs and constructing an empirical efficiency frontier based on the best-performing projects (Charnes et al., 1978).

Data processing was performed using DEAP version 2.1, which calculates the technical efficiency score for each DMU under the CRS assumption (Coelli, 1996). Efficiency scores range from 0 to 1, where a score equal to 1 indicates that a project is technically efficient, whereas scores below 1 indicate relative inefficiency. Following the efficiency estimation, efficient projects were identified as benchmark units, and improvement targets were generated for inefficient projects through potential input reduction and/or output enhancement. The analytical results were subsequently interpreted to formulate recommendations for improving the efficiency of DAK Fisik management in road infrastructure development projects in Buleleng Regency.

RESEARCH RESULT

DEA Efficiency Scores

DEA analysis generated efficiency scores ranging from 0 to 1. A Decision Making Unit (DMU) with an efficiency score of 1.000 is considered technically efficient because it lies on the efficiency frontier, indicating an optimal conversion of inputs into outputs. Conversely, DMUs with efficiency scores below 1.000 are classified as inefficient, implying that they still have potential to improve resource utilization. Under the input-oriented Constant Returns to Scale (CRS) model, an efficiency score below one indicates that the same level of output could theoretically be achieved with fewer inputs (Farrell, 1957).

Table 1. DEA CRS Input-Oriented Efficiency Scores

DMU	Project Description	Year	Efficiency Score	Category
A	Sanggalangit-Pantai Road Improvement	2024	0.889	Inefficient
B	Corot-Dencarik Road Improvement	2024	0.874	Inefficient
C	Dencarik-Cempaga Road Rehabilitation	2024	1.000	Efficient
D	Pejarakan-Pemandian Road Improvement	2022	0.996	Inefficient
E	Pejarakan-Batu Ampar Road Improvement	2022	0.858	Inefficient
F	Pemuteran-Pantai Road Improvement	2022	0.870	Inefficient
G	Banyupoh-Kertha Kawat Road Rehabilitation	2022	1.000	Efficient

H	Srikandi Road Rehabilitation	2022	0.858	Inefficient
I	Celukan Bawang-Harbor Road Improvement	2021	0.941	Inefficient
J	Lebah Siung-Pancoran Road Improvement	2021	1.000	Efficient
K	Pulau Komodo Road Improvement	2021	0.871	Inefficient
L	SP3 Tigawasa-Umasendi-Bingin Banjah Road Improvement	2021	0.875	Inefficient

Source: Processed by the authors (2026).

Among the 12 road projects analyzed, three DMUs (C, G, and J) achieved an efficiency score of 1.000, indicating that they operated on the efficiency frontier by optimally utilizing DAK Fisik funding and planned road length to produce realized road length and physical completion. Project J demonstrated particularly strong performance by achieving a physical completion rate of 116.59%, exceeding its initial target while maintaining technical efficiency. These findings indicate that project efficiency depends on the balance between inputs and outputs rather than the absolute size of the project budget (Charnes et al., 1978; Coelli, 1996).

The remaining nine DMUs (75%) recorded efficiency scores below 1.000, indicating varying degrees of technical inefficiency. The lowest scores were observed for DMU E and DMU H (0.858), suggesting that both projects could theoretically reduce input utilization by approximately 14.2% while maintaining the same level of output if they operated as efficiently as the frontier projects (Farrell, 1957). In contrast, DMU D achieved a score of 0.996, indicating that it was nearly efficient and required only minor improvements. DMU I, despite achieving a physical completion rate exceeding 100%, remained inefficient (0.941), demonstrating that higher physical achievement alone does not guarantee efficiency because DEA evaluates the proportional relationship between multiple inputs and outputs (Cooper et al., 2006).

Overall, the results indicate considerable variation in the efficiency of DAK Fisik management for road infrastructure projects in Buleleng Regency. Only 25% of the evaluated projects were technically efficient, whereas 75% exhibited opportunities for improving resource utilization. These findings provide a basis for identifying benchmark projects and formulating recommendations to enhance the efficiency of DAK Fisik implementation in future road infrastructure development programs (Rahmawati & Muhsyaf, 2025; Widodo, 2022).

Classification of Efficient and Inefficient Projects

DEA classified the 12 road infrastructure projects into efficient and inefficient Decision Making Units (DMUs) based on their CRS input-oriented efficiency scores. Projects with an efficiency score of 1.000 were classified as efficient because they operated on the efficiency frontier, whereas projects with scores below 1.000 were considered inefficient, indicating opportunities to optimize input utilization while maintaining the same level of output (Farrell, 1957).

Table 2. Classification of Road Projects Based on DEA Efficiency Scores

No	DMU	Project Description	Year	Efficiency Score	Category
1	A	Sanggalangit-Pantai Road Improvement	2024	0.889	Inefficient
2	B	Corot-Dencarik Road Improvement	2024	0.874	Inefficient
3	C	Dencarik-Cempaga Road Rehabilitation	2024	1.000	Efficient
4	D	Pejarakan-Pemandian Road Improvement	2022	0.996	Inefficient
5	E	Pejarakan-Batu Ampar Road Improvement	2022	0.858	Inefficient
6	F	Pemuteran-Pantai Road Improvement	2022	0.870	Inefficient
7	G	Banyupoh-Kertha Kawat Road Rehabilitation	2022	1.000	Efficient
8	H	Srikandi Road Rehabilitation	2022	0.858	Inefficient
9	I	Celukan Bawang-Harbor Road Improvement	2021	0.941	Inefficient
10	J	Lebah Siung-Pancoran Road Improvement	2021	1.000	Efficient
11	K	Pulau Komodo Road Improvement	2021	0.871	Inefficient
12	L	SP3 Tigawasa-Umasendi-BinginBanjah Road Improvement	2021	0.875	Inefficient

Source: Processed by the authors (2026).

As shown in Table 2, only three projects (25%)—DMUs C, G, and J—achieved full technical efficiency and therefore represent the best-performing projects in converting DAK Fisik resources into physical road infrastructure outputs. The remaining nine projects (75%) were classified as inefficient, with efficiency scores ranging from 0.858 to 0.996. Although several inefficient projects achieved physical completion rates of 100% or higher, DEA indicates that their input utilization remained relatively suboptimal compared with the efficient frontier, confirming that project efficiency depends on the proportional relationship between multiple inputs and outputs rather than output achievement alone (Charnes et al., 1978; Coelli, 1996).

Benchmark Analysis and Improvement Targets

Efficient DMUs serve as benchmark units for improving the performance of inefficient projects. In DEA, benchmark projects define the efficiency frontier and represent the most effective combination of budget allocation, planned road length, realized road length, and physical completion. Accordingly, DMUs C, G, and J were identified as benchmark projects because each achieved an efficiency score of 1.000 (Coelli, 1996).

Table 3. Benchmark Projects Identified by DEA

DMU	Project Description	Year	Efficiency Score	Status
C	Dencarik–Cempaga Road Rehabilitation	2024	1.000	Benchmark
G	Banyupoh–Kertha Kawat Road Rehabilitation	2022	1.000	Benchmark
J	Lebah Siung–Pancoran Road Improvement	2021	1.000	Benchmark

Source: Processed by the authors (2026).

The benchmark projects demonstrate different characteristics while maintaining optimal efficiency. DMUs C and G completed their planned road length with 100% physical completion, indicating balanced input utilization. Meanwhile, DMU J exceeded its planned output by achieving a physical completion rate of 116.59%, illustrating that higher outputs can be achieved without sacrificing efficiency when resources are managed appropriately (Farrell, 1957; Cooper et al., 2006).

To improve inefficient projects, DEA recommends optimizing input utilization rather than reducing project quality. The improvement strategy primarily focuses on enhancing budget allocation efficiency, aligning planned road length with project capacity, and strengthening project implementation to achieve comparable outputs with fewer resources.

Table 4. Improvement Priorities for Inefficient Projects

DMU	Efficiency Score	Improvement Priority
A	0.889	Optimize budget allocation and physical output planning
B	0.874	Align budget with realized road length
D	0.996	Minor improvement in input utilization
E	0.858	Review budget planning and project targets
F	0.870	Improve resource utilization efficiency
H	0.858	Strengthen planning and implementation control
I	0.941	Improve input management despite high physical achievement
K	0.871	Increase budget efficiency
L	0.875	Evaluate budget effectiveness relative to project outputs

Source: Processed by the authors (2026).

The lowest efficiency scores were observed for DMUs E and H (0.858), indicating the greatest improvement potential. Under the input-oriented DEA model, these projects could theoretically reduce input utilization by approximately 14.2% while maintaining current outputs. In contrast, DMU D (0.996) was nearly efficient and required only marginal improvements.

Overall, the benchmark analysis highlights that improving planning accuracy, budget allocation, implementation control, and cost efficiency is essential for enhancing the effectiveness of DAK Fisik-funded road infrastructure projects in Buleleng Regency (Farrell, 1957; Coelli, 1996; Widodo, 2022).

DISCUSSION

The DEA results indicate that the efficiency of DAK Fisik management in road infrastructure projects in Buleleng Regency varies considerably. Of the 12 Decision Making Units (DMUs) evaluated, only three projects (25%) were identified as technically efficient, while the remaining nine projects (75%) operated below the efficiency frontier. These findings suggest that most projects have not yet achieved the optimal combination of budget allocation and planned road length required to maximize realized road length and physical completion. According to Efficiency Theory, a production unit is considered efficient when it generates the maximum attainable output from a given set of inputs (Farrell, 1957). Similarly, the Production Frontier Theory explains that efficient units define the production frontier, whereas inefficient units remain below the frontier because their input utilization is not yet optimal (Charnes et al., 1978).

An important finding is that achieving or even exceeding the planned physical target does not necessarily imply technical efficiency. Several projects recorded physical completion rates of 100% or higher but still received efficiency scores below one. This result demonstrates that DEA evaluates the proportional relationship between multiple inputs and outputs rather than output achievement alone. Consequently, projects with high physical realization may still be inefficient if similar outputs could have been produced using fewer resources. These findings reinforce previous studies emphasizing that DEA provides a more comprehensive assessment of public sector performance than conventional measures based solely on financial absorption or physical completion (Coelli, 1996; Cooper et al., 2006).

The three efficient projects (DMUs C, G, and J) represent best practices in DAK Fisik management because they successfully transformed available resources into optimal infrastructure outputs. Interestingly, these benchmark projects differ substantially in project scale. DMU G achieved full efficiency despite having the smallest budget, whereas DMU J reached the efficiency frontier while exceeding its planned physical target. This finding suggests that project size is not the primary determinant of efficiency; rather, efficiency depends on how effectively financial resources and project planning are converted into infrastructure outputs. Similar conclusions have been reported in previous DEA studies, which found that efficient public projects are characterized by balanced resource utilization instead of large investment values alone (Cooper et al., 2006; Rahmawati & Muhsyaf, 2025).

Conversely, inefficient projects exhibited varying degrees of resource utilization inefficiency. Projects with the lowest efficiency scores demonstrated the greatest potential for input optimization under the input-oriented DEA model, while projects with efficiency scores close to one required only minor improvements to reach the efficiency frontier. The results also indicate that large-

budget projects are not necessarily more efficient than smaller ones. This finding implies that budget magnitude alone cannot be used as an indicator of project performance because technical efficiency depends on the relative balance between inputs and outputs. Differences in project characteristics, planning accuracy, implementation control, geographical conditions, and technical complexity may partially explain the observed efficiency variation, although these factors were beyond the scope of the DEA model and require further investigation (Halim & Yulianto, 2020).

The benchmark analysis provides practical implications for improving DAK Fisik management. Efficient projects can serve as reference units for less efficient projects by demonstrating more effective combinations of budget allocation, planned road length, realized road length, and physical completion. From a policy perspective, the findings suggest that improving project planning, strengthening budget estimation, enhancing implementation monitoring, and evaluating cost efficiency are essential for increasing the technical efficiency of future road infrastructure projects. Rather than focusing solely on budget absorption or physical completion, local governments should incorporate efficiency indicators into project evaluation to ensure that public resources generate the greatest possible infrastructure outcomes (Pardede, 2025; Widodo, 2022).

Overall, this study demonstrates that DEA is an effective analytical tool for evaluating the efficiency of DAK Fisik-funded road infrastructure projects because it simultaneously considers multiple inputs and outputs. The finding that only one-quarter of the projects operated efficiently highlights substantial opportunities for improving resource utilization in public infrastructure investment. These results contribute to the growing literature on public sector efficiency while providing empirical evidence that can support more effective planning and management of DAK Fisik in Buleleng Regency and other local governments implementing similar infrastructure programs (Rahmawati & Muhsyaf, 2025).

CONCLUSIONS AND RECOMMENDATIONS

This study evaluated the technical efficiency of Special Allocation Fund (DAK Fisik) management in road infrastructure projects in Buleleng Regency using the Data Envelopment Analysis (DEA) with a Constant Returns to Scale (CRS) input-oriented model. The results indicate that project efficiency varied considerably, with only 3 of the 12 Decision Making Units (25%) achieving full technical efficiency (DMUs C, G, and J), while the remaining 9 projects (75%) were classified as relatively inefficient. These findings demonstrate that achieving physical completion targets alone does not necessarily indicate efficient project performance, as efficiency depends on the proportional relationship between resource utilization and project outputs. The study confirms that DEA is an effective tool for evaluating the efficiency of public infrastructure investment by simultaneously considering multiple input and output variables.

The findings suggest that improving DAK Fisik management requires stronger project planning, more accurate budget allocation, continuous implementation monitoring, and benchmarking against efficient projects to optimize resource utilization. Nevertheless, this study is limited by its focus on technical efficiency using only four quantitative variables and a relatively small sample of 12 projects, without considering factors such as construction quality, geographical constraints, socioeconomic impacts, or contractor performance. Future studies are therefore encouraged to incorporate additional performance indicators, apply alternative efficiency measurement approaches such as Stochastic Frontier Analysis (SFA), and expand the analysis to other regions to provide a more comprehensive evaluation of public infrastructure efficiency.

ADVANCED RESEARCH

This study is limited to measuring the technical efficiency of DAK Fisik-funded road infrastructure projects in Buleleng Regency using an input-oriented DEA-CRS model with four variables: DAK Fisik budget, planned road length, realized road length, and physical completion rate. The analysis also includes only 12 Decision Making Units (DMUs), which may limit the generalizability of the findings. Future research should incorporate additional variables, such as road quality, project completion time, geographical conditions, maintenance costs, and socioeconomic impacts, to provide a more comprehensive assessment of infrastructure performance. Comparative analyses across different regions or the application of alternative efficiency measurement methods, such as Stochastic Frontier Analysis (SFA) or DEA-VRS models, are also recommended to validate and extend the present findings.

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