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(Allocative) Efficiency of the Resources: A Geographical Analysis of Public and Private Schools of Nepal

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Abstract

Allocative efficiency, using resources in optimal proportions based on input costs and their marginal contributions to output, is an emerging research construct, especially in resource-constrained countries like Nepal. This study examines the allocative efficiency of educational resources across Nepal's school system. Designed in a quantitative manner, this research employed a survey method. Utilizing empirical data of sources of school expenditure collected from a nationally representative sample of 650 schools, stratified by geographical regions (Himalayan, Hilly, and Terai), geographic location (urban and rural), and institutional type (public and private), the research evaluates the extent to which educational inputs are optimally allocated to maximize output. Key inputs assessed include expenditures on teaching personnel, management staff, support services, and instructional materials. By integrating exogenous variables such as region and school governance into the IOD (Indirect Output Distance) function, the study accounts for structural heterogeneity while estimating efficiency frontiers. A cost share derivative approach, derived from the logarithmic transformation of the IOD function, is employed as the central analytical framework to determine the theoretically optimal input shares. These optimal shares are then compared to observed cost allocations to identify overutilization or underutilization of resources. Positive deviations indicate overuse, while negative deviations signal resource underuse. Findings reveal considerable variation in allocative efficiency across regions and school types. Urban private schools in the Hilly region exhibit near-optimal resource allocation, whereas rural public schools in the Himalayan and Terai regions demonstrate significant inefficiencies, particularly due to disproportionate investments in labor and insufficient spending on learning materials. The study provides critical policy implications for cost-effective resource planning in low-income education systems, advocating for data-driven budgeting, input reallocation strategies, and decentralized school governance to promote both equity and efficiency in educational delivery.

Keywords: allocative efficiency, costs, geographical regions and locations, governance type, input-output, IOD function

(Allocative) Efficiency of the Resources: A Geographical Analysis of Public and Private Schools of Nepal

The efficient allocation of resources in the education sector is both a fiscal and moral imperative, especially in countries with constrained budgets and complex socio-geographic environments. In Nepal, where more than one-third of the national population resides in hard-to-reach areas and, about two-thirds of students (≈66%) attend community/public schools overall—with 64.7% at the basic level and 71.0% at the secondary level (CEHRD, Flash I Report 2081, 2024/25), achieving optimal use of limited educational resources is critical to advancing both equity and quality. While previous research (e.g, Haelermans et al., 2012) has made significant strides in identifying factors influencing educational outcomes, less attention has been paid to how efficiently resources are allocated across different types of schools and regional contexts. This gap is particularly salient in Nepal, a country characterized by sharp geographic diversity, like the Himalayan, Hilly, and Terai regions, and institutional heterogeneity, like public versus private schools operating in both rural and urban environments.

This study is motivated by the understanding that geographical and governance differences shape not only educational outcomes but also how key inputs such as teaching staff, leadership, support personnel, and instructional materials are allocated and utilized (Liao et al., 2024; Tang & Lan, 2025). Logistical constraints in Himalayan schools and stronger resource mobilization in urban private schools illustrate how context influences input use, raising critical questions about allocative efficiency across Nepal's diverse education system. These disparities make allocative efficiency a central concern for policymakers and educational economists.

The study conceptualizes allocative efficiency within welfare economics and production theory, defining it as the optimal distribution of inputs based on marginal productivity and prices (Coelli et al., 2005). By incorporating geographical disaggregation and governance structures, often overlooked in South Asian efficiency studies, the analysis reveals context-specific inefficiencies across regions, locations, and school types (Sarangapani & Pappu, 2021). This approach enables more precise identification of inefficiencies and supports the formulation of targeted, evidence-based policy interventions (World Bank et al., 2024).

Problem Statement

Despite sustained policy attention and increased investment, Nepal continues to face persistent challenges in the efficient use of educational resources, as allocative efficiency

remains largely underexplored relative to access, equity, and technical efficiency. Evidence suggests that inefficient teacher deployment, weak resource management, and misaligned spending priorities continue to constrain learning outcomes, even as education coverage expands (Asian Development Bank, 2025; Government of Nepal, Department of Education, 2012; World Bank, 2024). Moreover, existing efficiency studies in South Asia largely rely on aggregated analyses that obscure regional and governance-based disparities in resource use (Witte & López-Torres, 2017).

Nepal's Himalayan, Hilly, and Terai regions exhibit distinct educational and resource allocation challenges, further complicated by differences between centralized public schools and decentralized private institutions (World Bank, 2024). Current policy frameworks lack robust analytical tools to assess whether educational inputs are allocated in cost-optimal proportions, leading to persistent misallocation of scarce resources. This study addresses this gap by applying the Indirect Output Distance (IOD) function with exogenous geographic and governance factors to identify patterns of over- and underutilization and to inform context-sensitive policy reform.

Aim of the Study

The aim of this research is to examine the allocation of educational resources across Nepal's public and private schools, disaggregated by geographical regions (Himalayan, Hilly, and Terai) and rural-urban locations, in order to assess how efficiently these resources are being utilized.

Objectives of the Study

1. To estimate the allocative efficiency of schools in Nepal.
2. To compare the allocative efficiency between public and private schools across different geographical regions.
3. To analyze the variation in resource utilization between rural and urban public and private schools within each region.

Literature Review

Allocative Efficiency in Educational Contexts

Allocative efficiency remains relatively underexplored in education research despite its importance in budget-constrained systems, as schools may be technically efficient yet fail to allocate inputs in cost-optimal proportions (Worthington, 2001). The consideration of input prices and cost shares is therefore essential for assessing whether resources are used in

economically efficient combinations. Evidence suggests that misallocation can persist even when output levels appear satisfactory.

Studies from OECD and European contexts show that high-performing schools often exhibit allocative inefficiencies, particularly through excessive labor expenditure and insufficient investment in instructional materials (De Witte & López-Torres, 2017; OECD, 2020a). Applications of the IOD framework reveal systematic overutilization of teaching staff without compromising outcomes, indicating scope for cost optimization (Haelermans et al., 2012). In Nepal, similar patterns of input underuse and weak resource management have been documented in public schools, suggesting that many institutions operate below their allocative efficiency frontier (Bhutoria et al., 2022).

Public vs. Private School Efficiency in the Nepali Context

A central theme in the educational efficiency literature is the public–private divide, where private schools often demonstrate better performance, though this is influenced by multiple factors, including resource use, parental involvement, and student background characteristics (Glewwe & Kremer, 2006). Allocative efficiency studies offer deeper insight by showing that institutional autonomy plays a critical role in shaping how effectively resources are used. Evidence from Nigeria and Nepal indicates that private schools benefit from flexible resource management, while public schools are constrained by rigid budgeting and administrative controls (Aigbokhan, 2010; Lohani, 2022).

The efficiency gap between public and private schools reflects both managerial practices and structural conditions. Stronger accountability mechanisms and parental engagement contribute to private schools' relative efficiency advantages, rather than merely superior resource endowments (Glewwe & Kremer, 2006). In Nepal, centralized funding and governance continue to limit allocative efficiency in public schools, whereas private institutions adapt their input mix in response to market incentives and performance pressures (Lohani, 2022).

Theoretical Relevance of Allocative Efficiency to Nepal

Although Nepal's education policies increasingly emphasize decentralization and equity, empirical assessments of allocative efficiency remain limited, with most existing studies focusing on technical efficiency rather than cost-effective resource use (Bhatta & Pherali, 2017; Education Sector Plan 2021–2025). The reliance on formula-based grants and weak performance monitoring continues to constrain optimal budgeting and resource allocation (MoEST, 2021). A

contextually adapted IOD framework offers a robust analytical tool by integrating regional, institutional, and contextual variables to identify deviations from optimal input use. Such an approach can bridge existing empirical gaps and support evidence-based, differentiated policymaking aligned with Nepal's decentralized education governance goals.

Context of Nepali Schools: Regional and Rural–Urban, and Public and Private Dimensions

Nepal's education policies increasingly promote decentralization and equity, yet empirical evaluations of allocative efficiency remain scarce, as most studies continue to emphasize technical efficiency over cost-effective resource use (Bhatta & Pherali, 2017; Education Sector Plan 2021–2025). Continued reliance on formula-based grants and limited performance monitoring restricts optimal budgeting and resource allocation (MoEST, 2021). A contextually adapted IOD framework provides a robust means of integrating regional, institutional, and contextual factors to detect deviations from optimal input use. This approach helps close existing empirical gaps and supports evidence-based, differentiated policymaking consistent with Nepal's decentralized education governance objectives.

Research Gap

Several gaps exist in the current literature: a lack of studies applying IOD to low-income, diverse geographical settings; minimal exploration of allocative efficiency in relation to public-private dichotomies; and limited integration of rural-urban heterogeneity in efficiency assessments. This study aims to address these gaps by applying the IOD model across diverse Nepalese regions, evaluating cost shares across four input categories, and differentiating results by school type and location.

Conceptual Framework: Efficiency in Education

Nepal's education policies increasingly emphasize decentralization and equity, yet empirical analyses of allocative efficiency remain limited, with most research focusing on technical efficiency rather than cost-effective resource use (Bhatta & Pherali, 2017; Education Sector Plan 2021–2025). The continued reliance on formula-based grants and weak performance monitoring mechanisms constrains optimal budgeting and efficient resource allocation (MoEST, 2021).

A contextually adapted IOD framework offers a robust analytical approach by incorporating regional, institutional, and contextual variables to identify deviations from optimal

input use. This framework helps address existing empirical gaps and supports evidence-based, differentiated policymaking aligned with Nepal's decentralized education governance objectives.

Research Methodology

Research Design and Method

This study utilizes a quantitative, cross-sectional, and econometric approach to evaluate the allocative efficiency of educational resources in Nepalese schools, stratified across geographical regions, school types, and rural-urban locations. Employing the survey method, the research applies the Indirect Output Distance (IOD) function as the central analytical framework, which permits the inclusion of exogenous variables (e.g., geographical regions, locations, governance type) while estimating resource efficiency relative to a production frontier (Haelermans et al., 2012). This design and method are particularly suitable for understanding the structural dynamics of resource use across Nepal's heterogeneous educational landscape.

Sampling Design and Population

The sampling frame was constructed using the most recent Education Management Information System (EMIS) and Flash I Report (CEHRD, 2024/25). The total sample of 650 schools was determined using Yamane's (1967) formula for finite populations:

$$n = \frac{N}{1 + N(e^2)}$$

Where: n= sample size, N= total population (≈ 35,447 schools, CEHRD, 2024/25), e= desired margin of error (typically 4%). Substituting values:

$$n = \frac{35{,}447}{1 + 35{,}447(0.04^2)} = \frac{35{,}447}{1 + 35{,}447(0.0016)} = \frac{35{,}447}{57.7152} \approx 614.$$

Rounding up and adjusting for non-responses and geographical representativeness, the final sample was set at 650 schools, maintaining a 95% confidence level and ±4% margin of error.

Now, we will divide the national population by: Region -- Himalayan, Hilly, Terai; Location -- Rural, Urban; and School Type -- Public, Private. From the Flash Report 2081 (CEHRD, 2024/2025**)** and EMIS (2022), approximate national distributions based on national-level enrollment and school-type composition patterns are:

Table 1

Approximate National Distributions of Sample Schools

Region	Share of total schools	Rural (%)	Urban (%)	Public (%)	Private (%)
Himalayan	7%	70	30	90	10
Hilly	33%	50	50	80	20
Terai	60%	60	40	70	30

Now, using the formula $n_h = (N_h/N) \times 650$, the total sample (650) is distributed across strata proportionally:

Table 2

Stratification of Sample Schools with Rounded Results

Thus, the target population comprised all public and private schools in Nepal operating at the basic and secondary levels in all geographical regions and locations.

Region	Location	Public Schools	PrivateSchools	Subtotal
Himalayan	Rural	(0.07 × 0.70 × 0.90 × 650) = 28.665 → 29	(0.07 × 0.70 × 0.10 × 650) = 3.185 → 3	(0.07 × 0.70 × 650) = 31.85 → 32
	Urban	(0.07 × 0.30 × 0.90 × 650) = 12.285 → 12	(0.07 × 0.30 × 0.10 × 650) = 1.365 → 2	(0.07 × 0.30 × 650) = 13.65 → 14
Hilly	Rural	(0.33 × 0.50 × 0.80 × 650) = 85.80 → 86	(0.33 × 0.50 × 0.20 × 650) = 21.45 → 21	(0.33 × 0.50 × 650) = 107.25 → 107
	Urban	(0.33 × 0.50 × 0.80 × 650) = 85.80 → 86	(0.33 × 0.50 × 0.20 × 650) = 21.45 → 21	(0.33 × 0.50 × 650) = 107.25 → 107
Terai	Rural	(0.60 × 0.60 × 0.70 × 650) = 163.80 → 164	(0.60 × 0.60 × 0.30 × 650) = 70.20 → 70	(0.60 × 0.60 × 650) = 234
	Urban	(0.60 × 0.40 × 0.70 × 650) = 109.20 → 109	(0.60 × 0.40 × 0.30 × 650) = 46.80 → 47	(0.60 × 0.40 × 650) = 156
Totals		486	164	650

The sample reflects Nepal's educational realities: the Himalayan region has fewer schools overall; private schools are concentrated in urban centers; and public schools dominate in both urban and rural areas.

Table 3

Final Sample Distribution by Region, Location, and School Type

Geographical Region	Location	Public Schools	Private Schools	Total
Himalayan	Rural	29	3	32
Himalayan	Urban	12	2	14
Hilly	Rural	86	21	107
Hilly	Urban	86	21	107
Terai	Rural	164	70	234
Terai	Urban	109	47	156
Total		486	164	650

This distribution ensures that public schools outnumber private schools in each stratum, reflecting the national trend. Private schools remain concentrated in urban centers, whereas public schools maintain dominance in both urban and rural settings across all regions (MoEST, 2022; UNESCO, 2021).

Data Sources and Collection Procedures

Primary data were gathered using a structured questionnaire informed by educational efficiency literature (Fried et al., 2008; OECD, 2020a). Data covered: input categories -- teaching personnels, support staff, materials, and management; output -- standardized SEE/SLC student scores; and contextual factors – region and rurality, and school type.

Table 4

Mapping of Questionnaire Items to IOD Model Components

Variable Category	Example Questionnaire Item	Model Role	Permissibility	Rationale for Inclusion in IOD Model
Inputs (Resource Use)	Number of full-time equivalent teachers	Input	☑ Permissible	Represents labor intensity; key determinant of production efficiency.
	Number of administrative/support staff	Input	☑ Permissible	Captures non-teaching resource use.
	Annual expenditure on textbooks, ICT, and learning materials	Input	☑ Permissible	Reflects material input costs for allocative analysis.
	Number of functional classrooms	Input	☑ Permissible	Proxy for capital input (infrastructure).
	Number of administrators or head teachers	Input	☑ Permissible	Represents managerial input and governance efficiency.
Outputs (Educational Outcomes)	Average SEE/SLC pass percentage (last three years)	Output	☑ Permissible	Core performance indicator of student learning outcomes.
	Student retention rate	Output	☑ Permissible	Reflects internal efficiency of schooling.
	Transition rate from basic to secondary level	Output	☑ Permissible	Indicates schooling continuity and effectiveness.
Exogenous / Environmental Controls	Ecological region (Himalayan, Hilly, Terai)	Contextual Variable	☑ Permissible	Captures geographical heterogeneity in school environments.

Variable Category	Example Questionnaire Item	Model Role	Permissibility	Rationale for Inclusion in IOD Model
	Location type (rural or urban)	Contextual Variable	☑ Permissible	Reflects accessibility and infrastructure variation.
	School type (public or private)	Contextual Variable	☑ Permissible	Distinguishes governance-based efficiency differences.
	Frequency of School Management Committee (SMC) meetings	Contextual Variable	⚠ Conditional	Can proxy governance quality but not a direct input/output.
	Parental financial or voluntary contribution	Contextual Variable	⚠ Conditional	Reflects community support; may affect resource mobilization.
Excluded Variables (Non-Permissible)	Perception of school quality	Excluded	✗ Not Permissible	Subjective response; unsuitable for quantitative efficiency models.
	Teacher motivation or attitude levels	Excluded	✗ Not Permissible	Non-quantifiable behavioral construct.
	Preferred teaching method	Excluded	✗ Not Permissible	Process-based, not a measurable production variable.

Enumerators were deployed with region-specific language training. Data integrity was verified through field validation and telephone cross-checks. Secondary data from Flash Reports and EMIS were used for triangulation.

Analytical Framework

The IOD function measures the minimum proportional contraction of outputs required to be on the frontier given current inputs and environment (Coelli et al., 2005). It is specified as:

$IOD(y, w/C, z) = \min \{ \theta : (y\theta) \in P(w/C, z) \}$ Or,

$IOD(y, w/C, z) = \min \{ \theta : (y/\theta) \in P(w/C, z) \}$

Where yy = output, w/Cw/C = normalized input cost shares, zz = environmental factors.

The optimal cost share for input ii is computed using:

$S_i = \partial \ln IOD(y, w/C, z) / \partial \ln(w_i/C) \div \sum_n \partial \ln IOD(y, w/C, z) / \partial \ln(w_n/C)$

The allocative efficiency index (AE) is defined as:

$AE=1-1n\sum i=1n|Si- \hat{S}_i|$

Table 5

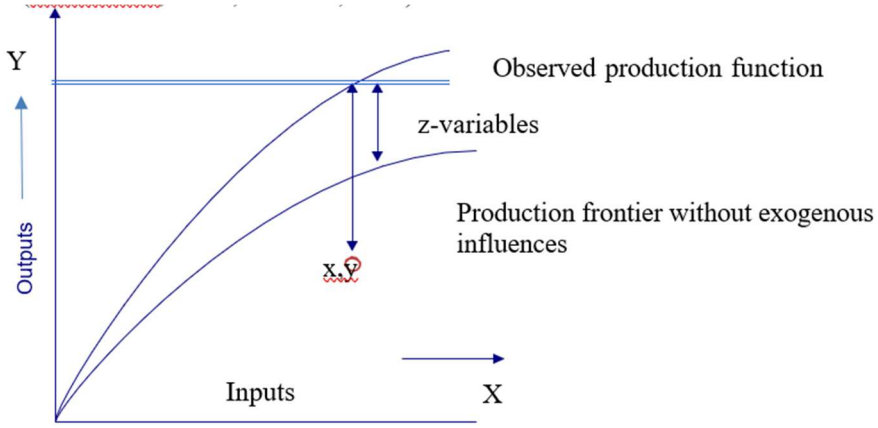
Variables and Measurement

Variable Category	Variable	Description
Inputs	Teaching personnel	Total salary, training expenditures
	Support staff	Non-teaching roles (librarian, handyboy/s, watchperson/s, cleaners)
	Management	Headteacher administration salaries
	Materials	Books, tech, supplies
Outputs	Academic performance	Standardized test scores (0–100)
Exogenous factors	Region, location, school type	Control variables (z)

All costs were adjusted using the Consumer Price Index (CPI) (Nepal Rastra Bank, 2024).

Figure1

TheProductionFrontierwithandwithoutEnvironmentalVariables



*Note.*This model is adopted from Haelermans, 2012, p. 62.

In this model, X axis shows inputs while Y axis shows outputs. The figure illustrates the relationship between inputs and outputs, highlighting the gap between observed production and the efficiency frontier under varying environmental conditions. Exogenous variables such as rurality, region, and school governance shift the frontier outward, recognizing that schools operate under unequal contextual constraints (Haelermans, 2012). This conceptualization emphasizes the importance of accounting for environmental heterogeneity in efficiency analysis.

Building on this framework, the study applies the Indirect Output Distance (IOD) function to estimate allocative efficiency while incorporating geographic and governance factors beyond managerial control (Haelermans, 2012). The IOD model uses cost share derivatives to identify optimal input allocations under cost minimization, with deviations indicating over- or underutilization of resources (Haelermans et al., 2012). Estimation was conducted using STATA 18 and R, supported by multiple imputation and standard diagnostic tests to ensure robustness (Kumbhakar & Lovell, 2000).

Table 6

Conversion of Letter Grading for Secondary Education Examination

Letter Grade	Grade Point (GPA)	Equivalent Percentage Range	Interpretation
A+	4.0	90–100	Outstanding
A	3.6–3.9	80–89	Excellent
B+	3.2–3.5	70–79	Very Good
B	2.8–3.1	60–69	Good
C+	2.4–2.7	50–59	Satisfactory
C	2.0–2.3	40–49	Acceptable
D+	1.6–1.9	30–39	Partially Acceptable
D	1.2–1.5	20–29	Insufficient
E	0.8–1.1	0–19	Very Poor

The data were collected during the 2023 academic year, covering the most recent results available during early 2024 fieldwork. This conversion allows valid comparison of school-level outcomes across governance types and regions while maintaining analytical consistency with continuous data requirements for efficiency estimation (MoEST, 2022; NEB, 2023).

Limitations with Regard to the Data

Despite my best efforts, some schools had incomplete financial records; learning output proxies may not capture soft skills; and the CPI may not reflect true regional price differences, particularly in remote Himalayan schools.Despite these, the study's robustness is ensured through methodological triangulation and frontier-adjusted comparisons (Fried et al., 2008; Haelermans et al., 2012).

Ethical Considerations

Research authority and ethical approval were granted by the Ministry of Education, Nepal. All participants provided informed consent. Schools were anonymized using coded identifiers, and data were stored securely on encrypted platforms.

Validity and Reliability

The findings show that public and rural schools tend to overuse teaching personnel while underinvesting in instructional materials and support staff, whereas private and urban schools remain closer to optimal input allocation due to greater managerial flexibility. These patterns reflect systemic constraints, including centralized budgeting in public schools and logistical challenges in rural areas. Overall, the results underscore the importance of differentiated funding mechanisms and enhanced decentralization to improve allocative efficiency across Nepal's diverse school contexts.

Results

The analysis combined descriptive and inferential statistical methods to address the study's objectives, beginning with descriptive statistics to summarize input use, costs, and performance across regions, locations, and governance types. Allocative efficiency was estimated using the Indirect Output Distance (IOD) function within a Stochastic Frontier Analysis framework, while ANOVA and post hoc tests examined efficiency differences across geographic and institutional groups (Fried et al., 2008; Kumbhakar et al., 2015). Multiple regression analysis was then employed to evaluate the influence of contextual factors on allocative efficiency, highlighting regional and institutional disparities.

Descriptive Statistics of Allocative Efficiency of Resources in Education

Table 6 highlights substantial variation in school-level costs and input allocation, with an average total cost of NPR 3.5 million and clear differences between public and private schools in spending priorities. The large standard deviations reflect heterogeneity in funding levels, school

size, and local economic conditions across schools. This variability, influenced by governance and geography, is critical for understanding allocative efficiency in Nepal's education system (UNESCO, 2021).

Table 7

Descriptive Statistics

Variable	Mean (NPR)	Std. Dev.	Min	Max
Teaching Personnel Cost	2,100,000	450,000	800,000	3,200,000
Management Cost	500,000	120,000	200,000	900,000
Support Staff Cost	350,000	95,000	100,000	800,000
Material Supply Cost	280,000	140,000	50,000	700,000
SEE/SLE Score (0–100)	61.3	12.4	35.5	91.0

The mean SEE/SLC score of 61.3 (SD = 12.4) reported in Table 6 represents the rescaled average performance across schools. Although Nepal's Secondary Education Examination (SEE) currently follows a letter grading system, numerical equivalents were used in this study to enable quantitative efficiency analysis. The grades (A+, A, B+, etc.) were converted to their corresponding grade point averages (GPA) and subsequently rescaled to a 0–100 scale, following the official conversion framework issued by the National Examination Board. The following table presents the conversion framework used in this study:

Cost Share Deviations

The analysis of allocative efficiency across school type and location was based on the mean deviation between optimal and observed input cost shares, derived from the Indirect Output Distance (IOD) model. Each school's deviation reflects how actual spending differs from the cost-minimizing proportion estimated through the efficiency frontier. Positive deviations indicate overutilization of an input, while negative values denote underutilization. To explore variation across categories, schools were grouped by governance (public or private) and by location (rural or urban). Comparative mean analysis and ANOVA tests were applied to assess whether deviations differed significantly between these groups. Table 8 summarizes mean deviations by school type and location.

Table 8

Summary of Mean Deviations by School Type and Location

Input Type	Optimal Share	Observed Share	Deviation	Interpretation
Teaching Personnel	0.52	0.63	+0.11	Overutilization
Management	0.14	0.13	-0.01	Near optimal
Support Staff	0.18	0.11	-0.07	Underutilization
Material Supply	0.16	0.13	-0.03	Underutilization

The results indicate that public and rural schools overutilize teaching personnel while underinvesting in instructional materials and support staff, whereas private and urban schools operate closer to optimal input shares due to more flexible management practices. These differences reflect systemic constraints such as centralized budgeting in public schools and logistical barriers in rural areas. Overall, the findings highlight the need for differentiated funding formulas and greater decentralization to improve allocative efficiency across Nepal's diverse school contexts.

Allocative Efficiency Scores by Region

Allocative efficiency was assessed to examine how effectively schools across Nepal's three ecological regions utilized their available resources relative to the cost-minimizing frontier. The criterion for analysis was the mean efficiency score for each region, ranging from 0 (completely inefficient) to 1(fully efficient), where, so, values closer to 1 indicate a higher level of allocative efficiency. The results summarize the overall capacity of schools to align their input proportions with the optimal cost structure estimated through the efficiency model. Table 9 displays average AE scores by region.

Table 9

Average AE Scores by Region

Regions	Allocative Efficiency
Himalayan Region	0.61
Hilly Region	0.74
Terai Region	0.68

The findings show that schools in the Hilly region achieved the highest average allocative efficiency (0.74), followed by those in the Terai (0.68) and Himalayan (0.61) regions. This

pattern suggests that schools located in moderately accessible areas are better positioned to balance their inputs, benefiting from improved infrastructure, teacher availability, and manageable school sizes. In contrast, schools in the Himalayan region face structural and logistical barriers that limit efficient resource use.

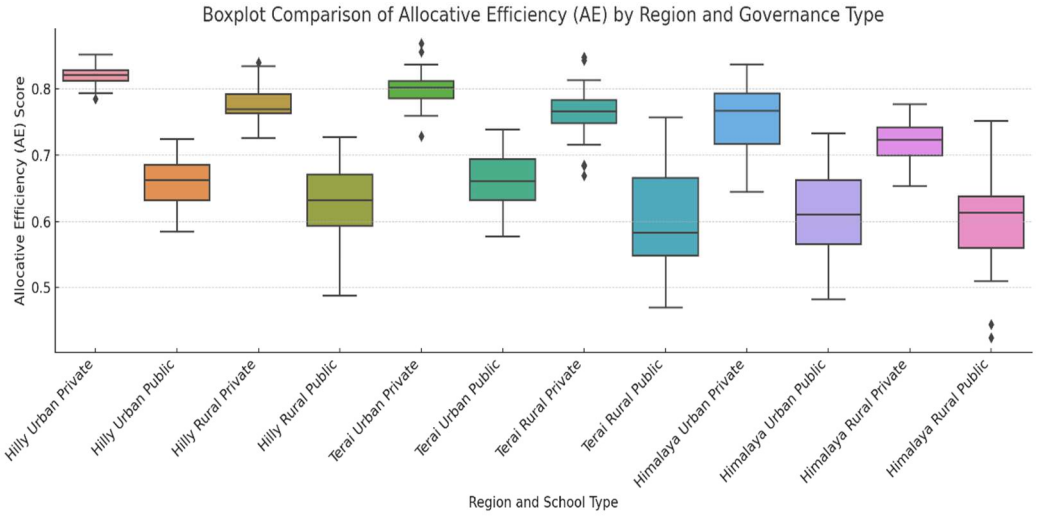
Lower efficiency in the Terai region compared to the Hilly region may reflect overcrowding, administrative inefficiencies, and uneven distribution of qualified teachers in densely populated districts. Overall, the regional variations indicate that efficiency is influenced not only by financial resources but also by contextual and geographical factors affecting how schools allocate and manage those resources.

Boxplot Comparison of AE by Region and Type

To illustrate disparities more clearly, Figure 2 presents a boxplot comparison of AE scores by region and governance type.

Figure 2

Comparison of AE by Region, Location, and Governance Type



The boxplot illustrates clear variation in allocative efficiency across regions and governance types, with private schools showing higher median efficiency and less variability, particularly in urban settings. Public schools exhibit lower medians and wider distributions, reflecting inconsistent resource allocation influenced by contextual and administrative constraints. Overall, the figure demonstrates that both geographical context and governance structure play significant roles in shaping schools' allocative efficiency.

Allocative Efficiency by School Type and Location

Allocative efficiency was analyzed across both school types and locations to examine how governance structures and spatial contexts influence resource use. The criterion for analysis was the mean allocative efficiency (AE) score for each category, ranging from 0 to 1, with higher scores indicating greater alignment between actual and optimal input allocation. This comparison helps identify which types of schools are utilizing their financial and human resources most effectively under varying contextual conditions.

Table 10

AE Scores Disaggregated by Location and Governance

School Type	Location	AE Score
Public	Rural	0.59
Public	Urban	0.68
Private	Rural	0.66
Private	Urban	0.81

The results indicate that private schools outperform public schools in both rural and urban contexts, with urban private schools achieving the highest allocative efficiency and rural public schools recording the lowest efficiency. The rural–urban divide further reveals that accessibility, infrastructure, and managerial autonomy significantly enhance efficient resource use. Overall, the findings demonstrate that both governance structure and location are critical determinants of how effectively schools allocate and manage their resources.

Regional Trends in Input Use

The regional breakdown reveals clear patterns of allocative inefficiency across school types. Himalayan schools exhibit substantial overutilization of teaching staff alongside marked underinvestment in instructional materials, while Hilly-region urban private schools operate close to optimal input allocation, and rural public schools show moderate inefficiencies. In the Terai region, public schools tend to overuse teaching personnel, and both public and private schools underinvest in support services.

These deviations, derived from comparisons between observed and IOD-estimated optimal input shares, highlight systematic misallocation of resources across contexts. Regression results further show that urban location and private governance significantly enhance allocative

efficiency, whereas schools in the Himalayan and Terai regions perform less efficiently than those in the Hilly region. The Gini analysis confirms moderate inequality in allocative efficiency—more pronounced among public schools—underscoring the need for targeted, context-sensitive policy interventions to reduce efficiency gaps.

Findings and Discussion

Findings

The observed disparities between public and private schools, as well as between rural and urban locations, stem largely from differences in governance structures, managerial autonomy, and access to resources. Public schools in Nepal operate under centralized regulations that restrict flexibility in staffing and spending, often leading to inefficient input allocation, whereas private schools can optimize resources due to greater administrative and financial autonomy (Lohani, 2022b). These disparities are further intensified by location, as urban schools benefit from better infrastructure and support, while rural and Himalayan schools face logistical and cost-related constraints. Consistent with human capital and production efficiency theories, these findings highlight the need for differentiated policies that enhance autonomy, improve rural resource access, and support evidence-based budgeting (Hanushek & Woessmann, 2020).

Comparison of the Findings with Global Literature

The findings on allocative efficiency are consistent with earlier evidence from both developed and developing contexts, where institutions with greater flexibility and decentralized decision-making demonstrate superior cost optimization (Aigbokhan, 2010; Haelermans et al., 2012; Lee, 2014). Recent studies further confirm that decentralized budgeting, school-based management, and localized decision-making significantly enhance allocative efficiency across South Asia, Africa, and Southeast Asia (Abbas & Iqbal, 2015; Alhassan, 2020; Tsutsumi et al., 2023). In Nepal, community-governed rural schools show relatively higher input efficiency, yet centralized budgetary control continues to constrain true resource reallocation, allowing private schools to maintain an efficiency advantage (Khanal & Sharma, 2024). Overall, global and national evidence underscores the importance of adaptive, region-sensitive, and evidence-based budgeting frameworks for improving allocative efficiency in education systems (UNESCO, 2021, 2025; World Bank, 2013).

Discussion

The results show that allocative efficiency in Nepal's school system varies systematically by geography, governance, and location, with urban private schools achieving the highest efficiency due to greater managerial flexibility and accountability, while rural public schools perform less efficiently under centralized budgeting and staffing rigidity (Hanushek & Woessmann, 2020). Schools in the Hilly region demonstrate relatively balanced input use, benefiting from moderate accessibility, whereas Himalayan schools face remoteness, high transport costs, and limited teaching resources, leading to lower efficiency outcomes (UNESCO, 2015). The widespread overutilization of labor inputs further reflects structural budget inefficiencies, where salary expenditures dominate at the expense of instructional and support investments, consistent with evidence from both developed and developing contexts (Haelermans et al., 2012; Worthington, 2001).

Box plot analyses indicate that urban private schools not only record higher mean efficiency but also exhibit more stable performance, as shown by narrower interquartile ranges, reflecting effective governance and responsive resource management (Glewwe & Kremer, 2006; Khandker et al., 2009). These patterns highlight persistent structural imbalances in Nepal's education financing shaped by terrain, administrative rigidity, and cost differentials across regions (Bedi & Garg, 2000). Collectively, the findings underscore the need for policy reforms that promote decentralization, enhance financial autonomy in public schools, and support more equitable investment strategies across regions and governance types.

Interpreting Teaching Personnel Overutilization

A key finding of this study is the systematic overutilization of teaching personnel across all school types, with a deviation of +0.11 from the optimal cost share, reflecting rigid hiring practices and politically driven funding structures commonly observed in education systems (Haelermans et al., 2012). In Nepal, this imbalance is reinforced by the allocation of more than 70% of the education budget to salaries, which constrains investment in instructional materials, technology, and infrastructure (MoEST, 2022). These inefficiencies are further exacerbated in Himalayan schools, where difficult terrain, teacher shortages, and logistical barriers limit effective resource use, a pattern consistent with evidence from other low-income and remote contexts (CEHRD, 2024; UNESCO, 2021; World Bank, 2022).

Underutilization of Materials and Support Inputs

Another notable inefficiency is the underinvestment in material supplies and support staff, particularly in rural and public schools, indicating a resource mix biased toward fixed recurrent costs rather than pedagogically effective inputs. Educational materials such as textbooks, digital content, and teaching aids, along with support staff, are known to enhance learning environments and outcomes, yet remain underprovided (Bedi & Garg, 2000; OECD, 2020b). This underutilization is most evident in the Himalayan region due to logistical constraints and weak supply chains—a pattern consistent with findings from other rural low-income contexts where limited non-labor investment restricts productivity gains (Aigbokhan, 2010).

Regional Disparities in Efficiency

The analysis demonstrates a clear regional efficiency gradient, with schools in the Hilly region outperforming those in the Himalayan and Terai zones due to better infrastructure, market access, and teacher availability, particularly among urban private institutions (Neupane & Shrestha, 2021). In contrast, Himalayan schools face compounded constraints such as difficult terrain, teacher shortages, and delayed material delivery, which significantly limit efficient resource use (Bhatta & Pherali, 2017; CEHRD, 2024; UNESCO, 2021). These findings underscore the importance of incorporating contextual and environmental factors into efficiency models, a key strength of the IOD framework, as lower performance reflects constrained optimization rather than managerial failure (Haelermans, 2012).

Urban-Rural Divide and Governance Structures

The higher allocative efficiency observed in urban private schools compared to rural public schools underscores the decisive role of institutional governance. Greater autonomy in budgeting, procurement, and personnel management allows private schools to adjust inputs flexibly, while public schools remain constrained by centralized bureaucratic controls (Lohani, 2022). This pattern is consistent with evidence that autonomy, accountability, and urban-scale advantages enhance efficiency in education systems in developing contexts (Glewwe & Kremer, 2006).

Implications of Gini Analysis of Efficiency

The Gini coefficient of 0.27 for allocative efficiency suggests moderate inequality in resource optimization across schools. The disparity is sharper within public institutions (Gini =

0.31) than private ones (Gini = 0.18), indicating that public education in Nepal is more vulnerable to inefficiency traps. This has equity implications: students in less efficient schools may receive lower-quality education, perpetuating cycles of disadvantage.

A focus on reducing intra-sectoral inequality is warranted, particularly through targeted grants and conditional transfers. International models such as Chile's preferential school subsidy and Brazil's FUNDEB have shown promise in this regard (OECD, 2012).

Role of Exogenous Variables

The regression results emphasize the significance of exogenous factors such as region, location, and governance as key determinants of allocative efficiency. Although these variables are beyond the direct control of individual schools, they strongly influence schools' capacity to optimize input use. Their integration into the IOD model enhances analytical robustness and aligns with methodological recommendations to account for environmental heterogeneity in school performance evaluation (Fried et al., 2008).

Conclusions and Implications

Conclusions

The findings have important policy implications, indicating that accountability mechanisms and funding formulas must be adjusted to reflect the contextual realities of schools, as uniform approaches can penalize disadvantaged institutions and misrepresent their efficiency. This study contributes to the educational efficiency literature by applying the IOD framework in a multi-ecological, low-income setting and extending prior Nepali research beyond technical efficiency to include allocative dimensions (Bhatta & Pherali, 2017). Additionally, by incorporating Gini coefficients to assess equity in efficiency, the study responds to calls for multidimensional performance evaluations that jointly consider efficiency and equity (UNESCO, 2021).

Policy and Practical Implications

The findings provide important guidance for policymakers and educational planners seeking to improve resource efficiency across Nepal's diverse school system. Persistent overuse of teaching personnel, alongside underinvestment in instructional materials and support services, highlights the need for more balanced, context-sensitive budgeting frameworks that account for regional constraints, such as terrain and accessibility (Haelermans et al., 2012; UNESCO, 2021). Public schools in rural and Himalayan areas require targeted material support and capacity-

building interventions, including textbooks, ICT infrastructure, and trained support staff. At the same time, private schools offer applicable models of autonomy-driven resource flexibility, although such practices should be monitored to ensure consistency with national equity objectives (Lohani, 2022).

Future Research Directions

Future research should use longitudinal and mixed-methods approaches to examine how policy reforms influence allocative efficiency over time and better to understand the behavioral and institutional drivers of inefficiency (Glewwe & Kremer, 2006). Comparative studies across South Asia and further refinement of the IOD model to incorporate non-cognitive outcomes would enhance the robustness and scope of efficiency analyses (OECD, 2020b). Together, these directions highlight the importance of data-driven and equity-sensitive reforms that account for the complex realities of Nepal's education system.

Limitations and Caution

While the findings are robust, certain limitations merit acknowledgment. First, the output variable—standardized student scores—captures only cognitive learning and may not reflect broader educational goals like citizenship or well-being. Second, data limitations constrained the inclusion of community and parental engagement variables, which are known to influence school performance.

Finally, although the IOD model is a powerful tool, its interpretation requires caution. A school's low efficiency score does not necessarily indicate poor management; it may reflect unobservable constraints or policy-induced limitations. Thus, any reform based on these results should be accompanied by qualitative assessments.

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