

Sustainable Education Practices in Resource-Limited Schools: A Comparative Mixed-Methods Multiple-Case Study of Diffun I and Diffun II Districts, Quirino, Philippines

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ABSTRACT

This study examined sustainable education practices in resource-limited public schools in Diffun I and Diffun II Districts, Quirino, Philippines. A convergent mixed-methods multiple-case design combined a probability survey of schools with documentary review and qualitative case inquiry. From a population of 46 schools—16 in Diffun I and 30 in Diffun II—32 schools were selected through proportionate stratified random sampling: 11 schools from Diffun I and 21 from Diffun II. Participants included 243 randomly selected teachers and 32 school heads, while eight maximum-variation focal schools informed the qualitative analysis. The Sustainable Education Practices Inventory assessed governance and policy, curriculum and pedagogy, resource efficiency, water, sanitation and hygiene, waste management, climate resilience and disaster risk reduction and management, and community engagement. School-level comparisons used Welch's t test and Hedges' g; associations used Spearman's rho; and predictors were estimated through Gaussian generalized estimating equations with exchangeable within-school correlation and robust standard errors. Sustainable education practices were extensive overall ($M = 3.60$, $SD = 0.56$ at the school level). Climate resilience and DRRM obtained the highest mean ($M = 3.70$), followed by curriculum and pedagogy ($M = 3.68$), whereas resource efficiency obtained the lowest mean ($M = 3.38$). Diffun II had a slightly higher overall mean ($M = 3.62$, $SD = 0.51$) than Diffun I ($M = 3.55$, $SD = 0.67$), but the difference was not statistically significant, $t(16.30) = -0.31$, $p = .764$, $g = 0.12$. In the cluster-aware model, policy alignment ($B = 0.275$, $p < .001$), leadership support ($B = 0.186$, $p < .001$), and community collaboration ($B = 0.104$, $p < .001$) positively predicted sustainable-practice scores; resource constraints were negative ($B = -0.100$, $p = .003$). Policy alignment also moderated the constraint–practice relationship ($B = 0.101$, $p = .001$). Qualitative findings showed that durable practices relied on explicit role assignment, low-cost routines, curriculum-linked learner participation, reciprocal community partnerships, and monitoring embedded in school plans. Infrastructure-dependent practices, particularly reliable WASH services and resource-efficient facilities, remained the most difficult to sustain. The results indicated that resource scarcity constrained implementation but did not determine it; organizational coherence and local implementation capacity substantially shaped school performance.

1. Introduction

Education for sustainable development (ESD) extended beyond teaching environmental topics. It concerned whether learners developed the knowledge, values, competencies, and agency to address interconnected environmental, social, and economic challenges, and whether schools themselves operated in ways that were consistent with those purposes. These aims were anchored in the 2030 Agenda for Sustainable Development²⁴ and UNESCO's ESD for 2030 framework, which emphasized transformation of learning environments, educator capacity, youth participation, local action, and policy support.²² The Green School Quality Standard further specified a whole-institution approach in which governance, facilities and operations, teaching and learning, and community engagement reinforced one another.²³ This orientation shifted the unit of analysis from isolated classroom lessons to the school as an organizational and social system.

A whole-school approach is especially important in settings where schools face persistent resource limitations. In such contexts, sustainable education cannot be reduced to acquiring solar panels, constructing specialized facilities, or purchasing new technologies. It must also include low-cost routines, responsible resource use, context-sensitive curriculum integration, safe water and sanitation practices, disaster preparedness, learner participation, and partnerships that extend the school's implementation capacity. Resource scarcity can restrict what schools can install or maintain, but it can also reveal whether sustainability is embedded in daily decision-making or remains dependent on one-time projects.^{9,14,23}

International research has shown that whole-school ESD is strengthened by proactive leadership, a shared vision, collaborative professional learning, student-centered approaches, and cooperation with local communities^{14,19}. Teachers are more likely to enact ESD when school structures provide time, materials, autonomy, and organizational support²⁰. School reform research likewise indicates that implementation improves when actors repeatedly negotiate a common purpose, build trust, use evidence, and connect

improvement routines to local conditions rather than treating reform as a compliance exercise¹⁰. These findings suggest that organizational coherence may partly compensate for resource scarcity.

The Philippine policy environment provides multiple entry points for sustainable education. Republic Act No. 9512 institutionalized environmental education across educational levels. Republic Act No. 9003 established ecological solid waste management responsibilities, while Republic Act No. 9729 mainstreamed climate change in government policy and Republic Act No. 10121 strengthened disaster risk reduction and management. Within basic education, DepEd Order No. 52, s. 2011 strengthened environmental education, DepEd Order No. 10, s. 2016 established the comprehensive Water, Sanitation and Hygiene in Schools program, and the Comprehensive DRRM in Basic Education Framework linked safety, continuity, and resilience to school management. These mandates collectively support a school-wide view of sustainability.^{5-8,15-18}

Policy presence, however, does not guarantee implementation. A school may formally cite environmental or safety policies while lacking an operational plan, designated personnel, monitoring indicators, or budget linkage. Conversely, schools with modest physical resources may demonstrate strong implementation through waste segregation routines, curriculum-based local problem solving, preventive maintenance, learner-led monitoring, rainwater conservation, community repair work, and coordinated emergency procedures. The key analytic question is therefore not only how many resources a school possesses, but how policies, people, and local relationships convert available resources into sustained practice.^{2,10}

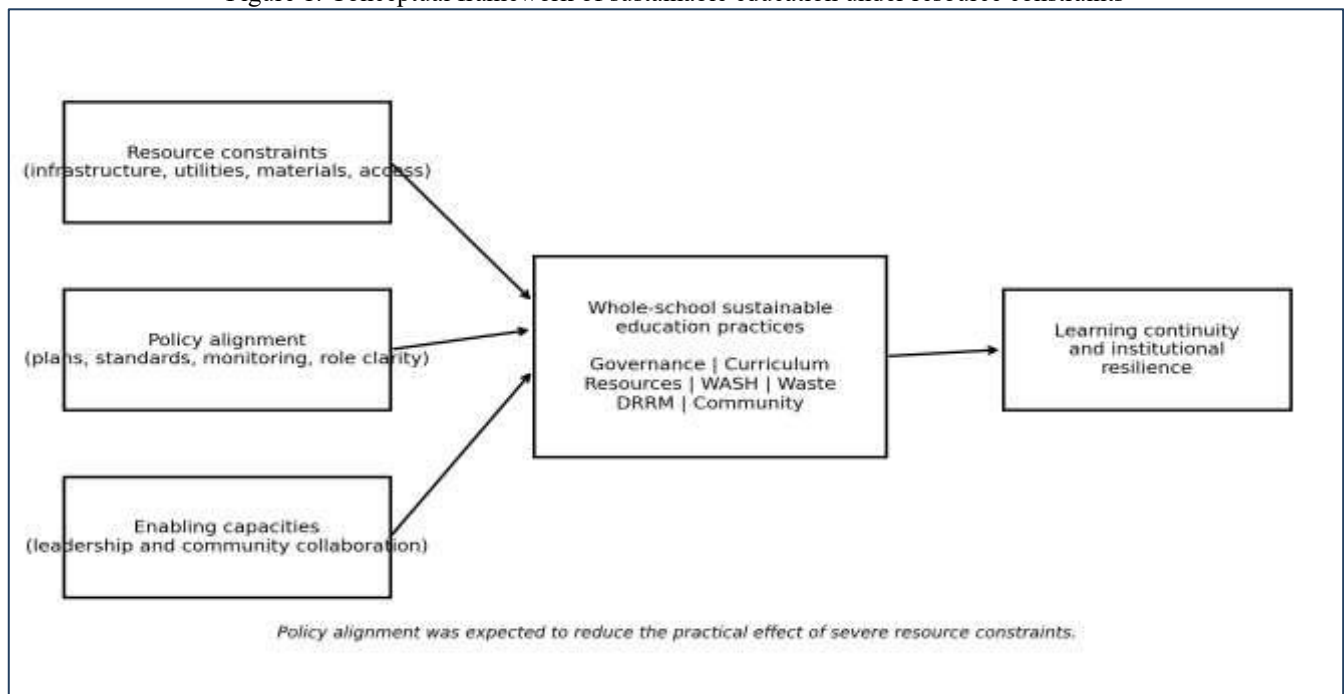
Diffun, Quirino offered a useful setting for examining this issue. The municipality is served by two school districts with unequal numbers of schools: Diffun I District has 16 schools and Diffun II District has 30 schools. Schools operate across communities that differ in accessibility, enrollment size, infrastructure, utility reliability, and proximity to external partners. A district comparison alone could obscure substantial variation among schools; nevertheless, a proportionate sample from both districts allowed the study to examine whether organizational factors worked similarly across the two administrative settings.

Existing Philippine studies and program reports have often documented specific environmental activities, WASH compliance, or disaster preparedness. Fewer studies have integrated these areas into a single whole-school construct while explicitly testing how resource constraints, policy alignment, leadership, and community collaboration interact. There is also limited district-level evidence from smaller provinces in Cagayan Valley. Addressing this gap is important because district and school leaders need evidence that distinguishes practices requiring capital investment from practices that can be strengthened through management, curriculum, participation, and partnership.

This study therefore examined sustainable education as an organizational capability under constraint. It combined quantitative comparison and explanatory analysis with qualitative case evidence. The approach was intended to identify both the level of implementation and the mechanisms through which resource-limited schools maintained, adapted, or discontinued sustainable practices.

1.1 Conceptual Framework

Figure 1. Conceptual framework of sustainable education under resource constraints



Note. Arrows indicate expected directional relationships. Policy alignment was tested both as a direct predictor and as a moderator of the relationship between resource constraints and sustainable education practices.

The conceptual framework integrated the whole-school approach to ESD with implementation-capacity and organizational-resilience perspectives. Sustainable education practices were treated as the central outcome and were represented by seven connected domains: governance and policy, curriculum and pedagogy, resource efficiency, WASH, waste management, climate resilience and DRRM, and community engagement. These domains reflected the expectation that learners should encounter sustainability both in formal instruction and in the routines, facilities, relationships, and decisions of the school.

Resource constraints were expected to exert a negative influence because inadequate water supply, unreliable electricity, insufficient learning materials, limited connectivity, difficult access, and deferred maintenance can reduce the consistency or reach of school initiatives. Policy alignment, leadership support, and community collaboration were treated as enabling capacities. Policy alignment represented the degree to which legal and departmental mandates were translated into school plans, budgets, roles, monitoring, and classroom expectations. Leadership support referred to prioritization, coordination, staff development, and problem solving. Community collaboration represented structured participation by parents, barangays, local government offices, civil-society groups, and local institutions.

The framework also proposed a buffering relationship. Strong policy alignment was expected to reduce the practical effect of resource constraints by clarifying priorities, protecting recurrent routines, aligning small expenditures, and coordinating external support. Sustainable-practice strength was further expected to relate positively to learning-continuity readiness because schools that routinely manage risks, resources, sanitation, communication, and stakeholder roles are better positioned to maintain essential educational functions during disruption.

1.2 Research Questions and Hypotheses

- What were the school and respondent characteristics of the selected schools in Diffun I and Diffun II Districts?
- What was the level of resource constraint among the selected schools?
- To what extent were sustainable education practices implemented across the seven whole-school domains?
- Did sustainable education practice scores differ significantly between Diffun I and Diffun II Districts?
- How were resource constraints, policy alignment, leadership support, community collaboration, sustainable education practices, and learning-continuity readiness related?
- Which organizational factors predicted sustainable education practice scores after within-school dependence was accounted for?
- How did focal schools sustain education practices despite resource limitations?

The null hypothesis for the district comparison stated that the mean overall sustainable-practice score did not differ between Diffun I and Diffun II. The explanatory hypothesis stated that policy alignment, leadership support, and community collaboration would positively predict sustainable practices, while resource constraints would predict lower practice scores. A further hypothesis stated that policy alignment would weaken the negative relationship between resource constraints and sustainable practices.

2. Methods

2.1 Research Design

The study used a convergent mixed-methods multiple-case design. The quantitative component measured school resource constraints, organizational enabling conditions, sustainable education practices, and learning-continuity readiness across a probability sample of schools. The qualitative component examined how selected schools translated policy into routine practice, mobilized resources, involved learners and stakeholders, and responded to implementation barriers. Quantitative and qualitative findings were analyzed separately and integrated through a joint display and explanatory narrative.⁴

The design was appropriate because the study addressed both prevalence and process. Survey and documentary measures estimated the extent and correlates of practice across the two districts, while focal cases clarified why similar levels of constraint sometimes produced different implementation outcomes. The school served as the principal case and clustering unit; teacher responses were treated as nested observations within schools.

2.2 Study Setting and Population

The study was conducted in Diffun I and Diffun II Districts in the Municipality of Diffun, Province of Quirino, Cagayan Valley Region. The school population comprised 46 public basic education schools: 16 schools in Diffun I District and 30 schools in Diffun II District. The population included schools with varied enrollment sizes and access conditions. For confidentiality, sampled schools were assigned alphanumeric codes and were not ranked by district or individual identity.

The unit of institutional analysis was the school. School heads supplied administrative and documentary information, while teachers assessed the consistency of practices encountered in instruction, operations, learner activities, and school-community initiatives. This respondent combination reduced sole-source dependence by separating several organizational predictors from the teacher-rated outcome.

2.3 Sampling and Participants

The number of sampled schools was determined using Cochran's formula with finite-population correction. With a 95% confidence level, maximum variability ($p = .50$), a 10% precision level suitable for the bounded school population, and $N = 46$ schools, the required sample was 31.34 schools and was rounded upward to 32. Proportionate allocation yielded 11 of the 16 schools in Diffun I and 21 of the 30 schools in Diffun II.³

Within each district, schools were listed and assigned unique numbers. A computer-generated random sequence was used to select the required number without replacement. Replacement was permitted only when a selected school was administratively ineligible or unable to participate; no replacement was needed. Within each selected school, seven or eight teachers were chosen from the official faculty roster through systematic random sampling after a random start. All 32 school heads participated. The completed quantitative sample comprised 243 teachers—85 from Diffun I and 158 from Diffun II—and 32 school heads.

For the qualitative component, eight focal schools were selected from the 32 survey schools using maximum-variation criteria. Selection represented both districts, different access settings, different resource-constraint levels, and contrasting sustainable-practice scores. Eighteen participants took part in the qualitative inquiry, including eight school heads, eight teacher coordinators or classroom teachers, and two district-level key informants. Case selection occurred after initial quantitative scoring so that explanations could be sought for both stronger and weaker implementation patterns.

Table 1. Population, school sample, and respondents by district

District	School population	Schools sampled	Sampling fraction (%)	Teacher respondents	School heads
Diffun I	16	11	68.8	85	11
Diffun II	30	21	70.0	158	21
Total	46	32	69.6	243	32

2.4 Measures

Resource Constraints Index (RCI). The RCI combined 12 school-level indicators covering adequacy and reliability of classrooms and learning spaces, water supply, sanitation facilities, electricity, connectivity, learning materials, waste-handling facilities, maintenance capacity, transport or access difficulty, emergency supplies, and discretionary operating resources. Indicators were scored and transformed to a 0–100 index, with higher scores indicating more severe constraints. Pre-specified descriptive bands were 0–49 low, 50–64 moderate, 65–79 high, and 80–100 severe. The index was completed by the school head and verified against available school records and observation notes.

Sustainable Education Practices Inventory (SEPI). The SEPI contained 35 items distributed equally across seven domains: governance and policy; curriculum and pedagogy; resource efficiency; WASH; waste management; climate resilience and DRRM; and community engagement. Teachers rated the consistency of each practice from 1 (not practiced) to 5 (consistently institutionalized). Domain and overall scores were calculated as item means. Interpretive ranges were 4.20–5.00 very extensive, 3.40–4.19 extensive, 2.60–3.39 moderate, 1.80–2.59 limited, and 1.00–1.79 very limited.

Policy Alignment Index. A 10-item school-head scale and document checklist assessed whether sustainability-related mandates appeared in school improvement plans, annual implementation plans, budgets, committee assignments, curriculum or learning activity plans, WASH monitoring, waste-management procedures, DRRM plans, and reporting processes. Items were rated from 1 to 5 and averaged. Documentary evidence was used to resolve discrepancies between self-report and formal records.

Leadership Support Scale. Eight items measured whether school leaders communicated priorities, assigned clear responsibilities, protected implementation time, supported professional learning, used monitoring evidence, coordinated maintenance, recognized learner and staff participation, and acted on implementation barriers. The response range was 1–5.

Community Collaboration Scale. Eight items measured the regularity and usefulness of participation by parents, barangays, local government units, civic organizations, local businesses, and other external partners in planning, resource mobilization, technical support, monitoring, and learner activities. Transactional donations without evidence of shared planning were scored lower than recurring, role-defined collaboration.

Learning-Continuity Readiness Index. Eight indicators assessed updated risk information, alternative communication channels, continuity roles, access to essential learning materials, emergency WASH provisions, protection of school records, stakeholder contact systems, and procedures for resuming instruction after disruption. Scores ranged from 1 to 5.

Qualitative protocol. Semi-structured interviews and case evidence review focused on the origin of sustainability initiatives, policy translation, resource decisions, learner participation, inter-agency support, maintenance, monitoring, discontinuation, and adaptation. The protocol avoided asking participants to evaluate named schools outside their own setting.

2.5 Instrument Development, Validity, and Reliability

Instrument content was mapped against the ESD for 2030 priority areas, UNESCO's whole-institution and green-school dimensions, Philippine environmental education and solid-waste mandates, WinS standards, and the Comprehensive DRRM in Basic Education Framework. Items were written to capture observable routines rather than general attitudes. A review panel composed of specialists in educational management, environmental education, school health, DRRM, and quantitative research examined relevance, clarity, and duplication. Items requiring substantial capital investment were distinguished from organizational or behavioral practices so that the scale would not equate sustainability solely with infrastructure wealth.^{5–8,22,23,27–29}

Internal consistency was evaluated using Cronbach's alpha. Domain coefficients ranged from .825 to .856, and the overall 35-item scale yielded alpha = .965. All domains exceeded the conventional .70 threshold. The generalized estimating equation produced a working correlation of .182, confirming dependence among teachers within the same school.

Table 2. Reliability of the Sustainable Education Practices Inventory

Domain	Items	Cronbach's alpha	Interpretation
Governance and policy	5	0.828	Good
Curriculum and pedagogy	5	0.825	Good
Resource efficiency	5	0.842	Good
Water, sanitation, and hygiene	5	0.856	Good
Waste management	5	0.833	Good
Climate resilience and DRRM	5	0.828	Good
Community engagement	5	0.839	Good
Overall scale	35	0.965	Excellent

Note. Interpretations were descriptive: .70–.79 acceptable, .80–.89 good, and .90 or higher excellent. A high overall alpha did not replace domain-level analysis.

2.6 Data Collection Procedures

Data collection occurred during the second semester of School Year 2025–2026. After district coordination, selected schools received an orientation describing the study purpose, confidentiality procedures, required records, and respondent-selection process.

Teacher survey administration occurred during an agreed non-instructional period. School heads completed the organizational scales and facilitated access to non-identifying documentary evidence, including school plans, committee assignments, monitoring forms, and activity or maintenance records.

Two trained data collectors reviewed completeness and applied a uniform evidence checklist. Survey forms did not collect learner names or direct teacher identifiers. Responses were encoded twice and compared for discrepancy. School-level aggregates were generated only after teacher forms had passed completeness checks. Qualitative interviews were conducted after preliminary quantitative analysis. Case summaries combined interview accounts with documentary and observational evidence and were returned to the coding team for consistency review.

2.7 Statistical and Qualitative Analysis

Descriptive statistics included frequencies, percentages, means, standard deviations, and 95% confidence intervals. Because district strata contained unequal numbers of sampled schools and variance equality could not be guaranteed, district comparisons were performed on school-aggregated scores using Welch's independent-samples t test. Effect magnitude was expressed as Hedges' g with small-sample correction; positive g values indicated higher means in Diffun II.¹¹

School-level associations were examined using Spearman's rank-order correlation because the number of schools was limited and several organizational indicators were bounded. The primary explanatory analysis used a Gaussian generalized estimating equation with an exchangeable working-correlation structure, school as the clustering variable, and robust standard errors. The dependent variable was the teacher-level overall sustainable-practice score. Continuous predictors—resource constraints, policy alignment, leadership support, and community collaboration—were standardized. District was entered as an indicator variable, and a resource-constraint-by-policy-alignment interaction tested the buffering hypothesis. Statistical significance was evaluated at $\alpha = .05$ using two-tailed tests. Interpretation emphasized estimates, confidence intervals, and practical meaning rather than significance alone.¹²

Qualitative data were analyzed through reflexive thematic analysis following familiarization, initial coding, pattern development, theme review, definition, and integration¹. Coding combined deductive categories from the conceptual framework with inductive categories emerging from focal cases. No invented participant quotations were used; results were reported as analytic themes and evidence patterns. Integration occurred through a joint display comparing quantitative results, qualitative explanations, and implications.

2.8 Ethical Safeguards

The study protocol protected voluntary participation, confidentiality, and non-retaliation. Teachers completed the instrument without the school head present, and school-level results were reported using codes or aggregates. Documentary review excluded personal records and learner-level information. Interview participants were informed that participation would not affect employment, evaluation, or access to programs. The protocol required administrative permission, informed consent, secure storage, restricted access, and deletion of direct identifiers after verification.

3. Results

3.1 School and Respondent Profile

All 32 randomly selected schools were retained in the analysis. Diffun I contributed 11 schools and 85 teacher respondents, while Diffun II contributed 21 schools and 158 teacher respondents. Teacher cluster sizes ranged from seven to eight per school. The sample included 15 small, 13 medium, and four large schools. Ten schools were classified as accessible, nine as moderately remote, and 13 as remote based on travel and service-access indicators.

Diffun II contained a larger number of small and remote schools in the sample. Eleven of its 21 schools were small and 10 were remote. In Diffun I, four of 11 schools were small and three were remote. These differences were treated as contextual variation rather than evidence of district quality.

Table 3. Profile of sampled schools by district

Characteristic	Diffun I (n = 11)	Diffun II (n = 21)	Total (N = 32)
Small schools	4 (36.4%)	11 (52.4%)	15 (46.9%)
Medium schools	5 (45.5%)	8 (38.1%)	13 (40.6%)
Large schools	2 (18.2%)	2 (9.5%)	4 (12.5%)
Accessible	5 (45.5%)	5 (23.8%)	10 (31.3%)
Moderately remote	3 (27.3%)	6 (28.6%)	9 (28.1%)
Remote	3 (27.3%)	10 (47.6%)	13 (40.6%)

Note. Percentages were calculated within district for the first two columns and across all sampled schools for the total column.

3.2 Resource-Constraint Profile

The mean Resource Constraints Index across sampled schools was 68.44 (SD = 9.84), placing the average school in the high-constraint range. Two schools were in the low range, 10 were in the moderate range, 16 were in the high range, and four were in the severe range. The distribution showed that material and access limitations were widespread but not uniform.

Diffun I had a mean constraint score of 63.10 (SD = 11.93), while Diffun II had a mean of 71.24 (SD = 7.41). The Welch comparison approached but did not reach the .05 criterion, $t(14.16) = -2.06$, $p = .058$, $g = 0.86$. The effect-size estimate suggested a potentially meaningful contextual difference, but the result was not treated as a statistically established district difference.

Table 4. Resource-constraint levels among sampled schools

Constraint category	Number of schools	Percentage
Low (0–49)	2	6.2

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Constraint category	Number of schools	Percentage
Moderate (50–64)	10	31.2
High (65–79)	16	50.0
Severe (80–100)	4	12.5
Total	32	100.0

Note. Higher values indicated greater limitation in infrastructure, utilities, materials, access, maintenance, and operating flexibility.

3.3 Extent of Sustainable Education Practices

The overall school-level sustainable education practice score was 3.60 (SD = 0.56; 95% CI [3.39, 3.80]), interpreted as extensive. The highest domain was climate resilience and DRRM (M = 3.70), followed by curriculum and pedagogy (M = 3.68), community engagement (M = 3.65), governance and policy (M = 3.62), and waste management (M = 3.62). WASH was also extensive but lower (M = 3.52). Resource efficiency produced the lowest mean (M = 3.38), positioned immediately below the threshold for extensive practice and therefore interpreted as moderate.

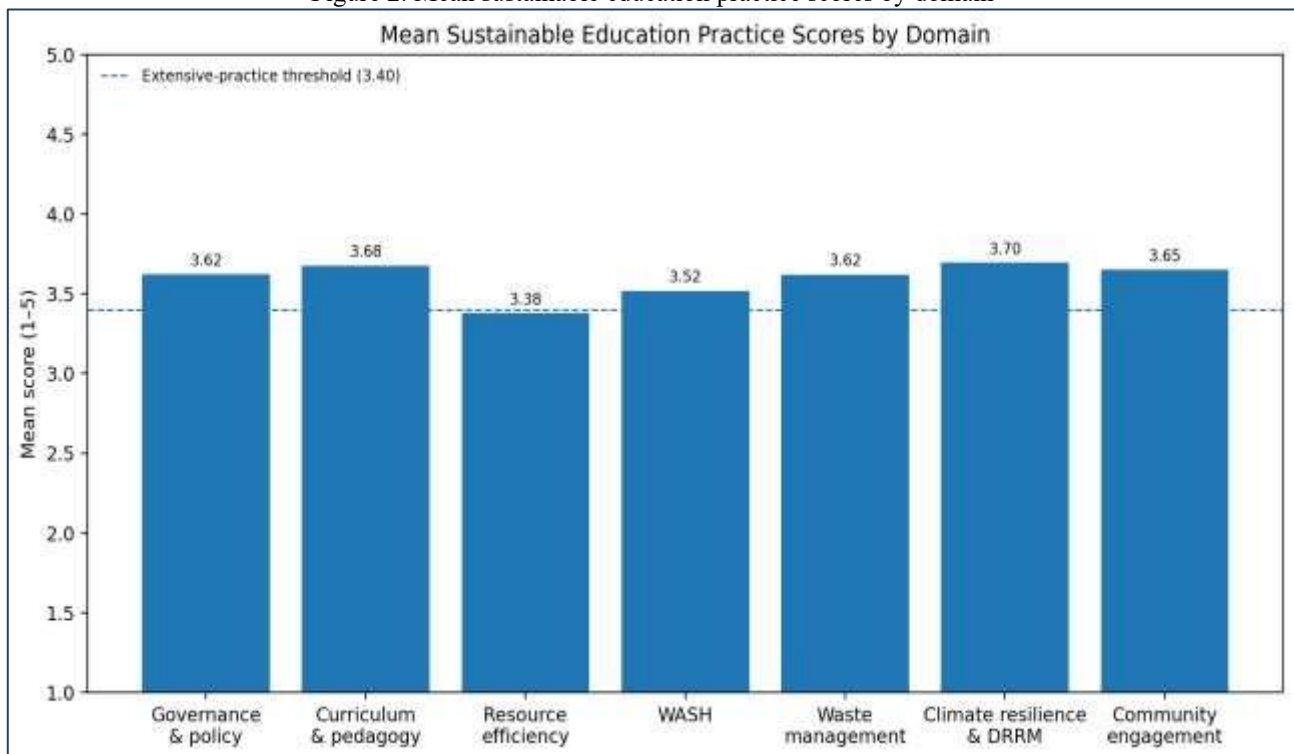
The pattern indicated that schools more consistently implemented domains that could be organized through routines, curriculum integration, role assignments, drills, communication, and participation. Practices that depended heavily on reliable utilities, specialized infrastructure, replacement equipment, or recurrent maintenance were less consistent. The broad confidence intervals also indicated meaningful variation among schools despite a common district policy environment.

Table 5. Sustainable education practice scores by domain

Domain	Mean	SD	95% CI	Interpretation
Governance and policy	3.62	0.57	3.42–3.83	Extensive
Curriculum and pedagogy	3.68	0.54	3.48–3.87	Extensive
Resource efficiency	3.38	0.56	3.18–3.58	Moderate
Water, sanitation, and hygiene	3.52	0.59	3.31–3.73	Extensive
Waste management	3.62	0.56	3.42–3.82	Extensive
Climate resilience and DRRM	3.70	0.56	3.50–3.90	Extensive
Community engagement	3.65	0.59	3.44–3.86	Extensive

Note. Scale: 1.00–1.79 very limited, 1.80–2.59 limited, 2.60–3.39 moderate, 3.40–4.19 extensive, and 4.20–5.00 very extensive. Statistics were computed from school-aggregated teacher means.

Figure 2. Mean sustainable education practice scores by domain



Note. The dashed line marks the lower boundary of the extensive-practice range.

3.4 District Comparison

Diffun II recorded a slightly higher overall mean (M = 3.62, SD = 0.51) than Diffun I (M = 3.55, SD = 0.67). The difference was not significant, $t(16.30) = -0.31$, $p = .764$, and the effect was small ($g = 0.12$). None of the seven domain comparisons reached statistical significance, and all effect sizes were small. The district-level null hypothesis was therefore retained. The result did not imply that all schools were similar; instead, it indicated that between-school variation within districts was greater than the average difference between districts.

Table 6. School-level comparison of sustainable education practices by district

Domain	Diffun I M (SD)	Diffun II M (SD)	t	df	p	Hedges g
Governance and policy	3.56 (0.69)	3.66 (0.51)	-0.43	15.72	0.676	0.17
Curriculum and pedagogy	3.62 (0.62)	3.71 (0.51)	-0.39	17.24	0.704	0.15
Resource efficiency	3.32 (0.68)	3.41 (0.51)	-0.41	16.13	0.684	0.16
Water, sanitation, and hygiene	3.49 (0.71)	3.54 (0.54)	-0.20	16.24	0.844	0.08
Waste management	3.58 (0.69)	3.64 (0.50)	-0.29	15.74	0.777	0.12
Climate resilience and DRRM	3.64 (0.64)	3.72 (0.53)	-0.36	17.24	0.726	0.14
Community engagement	3.64 (0.68)	3.66 (0.55)	-0.06	17.08	0.951	0.02
Overall practices	3.55 (0.67)	3.62 (0.51)	-0.31	16.30	0.764	0.12

Note. Welch's t test was applied to school-level means. Positive Hedges g values indicated higher scores in Diffun II. No p value was below .05.

3.5 Relationships Among Organizational Conditions and Outcomes

Sustainable education practices showed strong positive associations with policy alignment ($\rho = .80$, $p < .001$) and leadership support ($\rho = .76$, $p < .001$), and a moderate positive association with community collaboration ($\rho = .47$, $p = .007$). Resource constraints were negatively related to sustainable practices ($\rho = -.53$, $p = .002$). These results supported the view that material conditions mattered, but organizational coherence and enabling relationships were at least as important.

Sustainable practices were strongly related to learning-continuity readiness ($\rho = .79$, $p < .001$). Policy alignment had an especially strong association with continuity readiness ($\rho = .88$, $p < .001$), while resource constraints were negatively related to continuity readiness ($\rho = -.69$, $p < .001$). The pattern suggested that schools with integrated plans, roles, monitoring, and policy-linked routines were better prepared to maintain essential functions during disruption.

Table 7. Spearman correlations among school-level variables

Variable	1	2	3	4	5	6
Sustainable practices	1.00	—	—	—	—	—
Resource constraints	-0.53**	1.00	—	—	—	—
Policy alignment	0.80***	-0.50**	1.00	—	—	—
Leadership support	0.76***	-0.30	0.50**	1.00	—	—
Community collaboration	0.47**	-0.08	0.18	0.28	1.00	—
Continuity readiness	0.79***	-0.69***	0.88***	0.60***	0.16	1.00

Note. N = 32 schools. * $p < .05$. ** $p < .01$. *** $p < .001$. Higher resource-constraint scores indicated more severe limitation.

3.6 Predictors of Sustainable Education Practices

The generalized estimating equation used 243 teacher observations clustered within 32 schools. The estimated within-school exchangeable correlation was .182, and the squared correlation between observed and fitted values was .852. After the organizational variables and district were considered simultaneously, policy alignment remained the strongest predictor. A one-standard-deviation increase in policy alignment corresponded to a 0.275-point increase in the overall sustainable-practice score (95% CI [0.207, 0.343], $p < .001$). Leadership support also had a positive effect ($B = 0.186$, 95% CI [0.139, 0.234], $p < .001$), followed by community collaboration ($B = 0.104$, 95% CI [0.060, 0.148], $p < .001$).

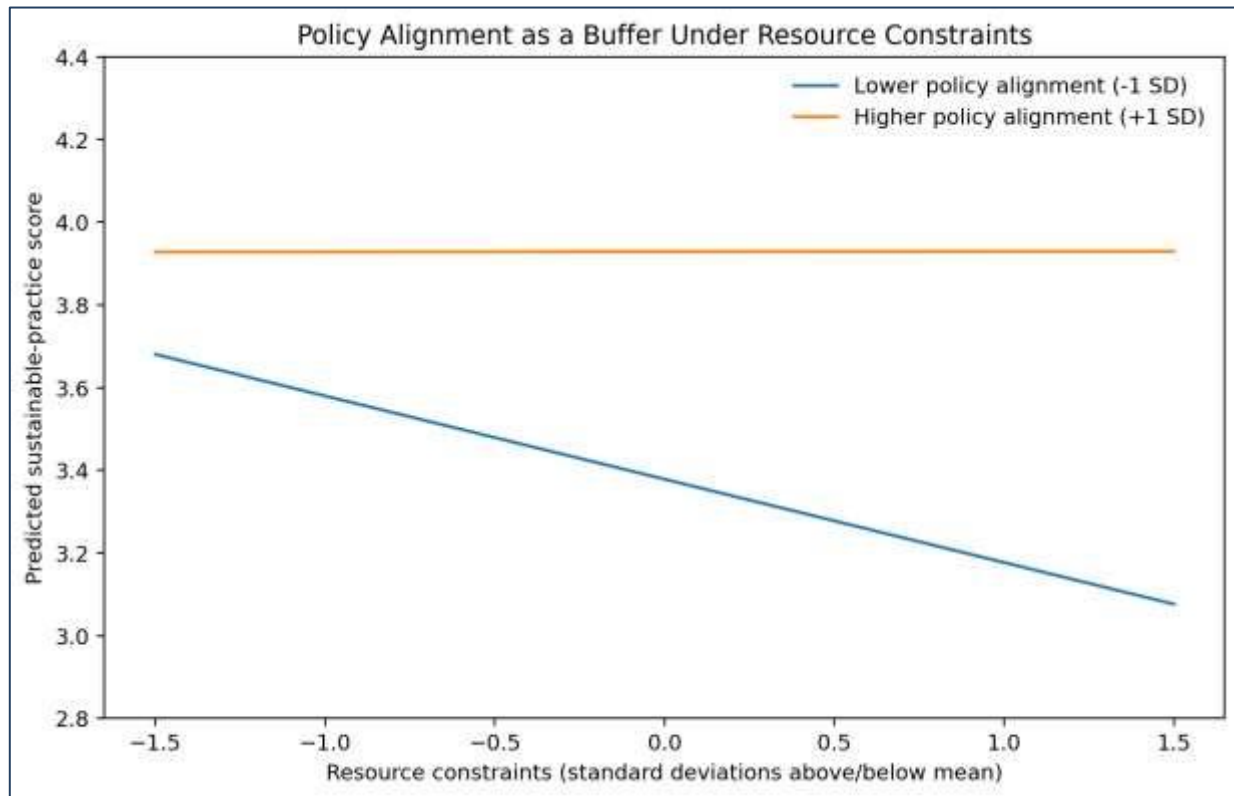
The direct resource-constraint coefficient was negative and statistically significant after enabling capacities were controlled ($B = -0.100$, 95% CI [-0.166, -0.035], $p = .003$). District had no independent effect ($B = -0.009$, $p = .904$). The interaction between resource constraints and policy alignment was positive and significant ($B = 0.101$, 95% CI [0.040, 0.161], $p = .001$). This interaction indicated that stronger policy alignment reduced the decline in practice scores associated with more severe constraints. At high policy alignment, predicted practice levels remained comparatively stable even as constraint levels increased; at lower policy alignment, the predicted score declined more sharply.

Table 8. Generalized estimating equation predicting teacher-rated sustainable education practices

Predictor	B	Robust SE	z	95% CI	p
Intercept	3.653	0.068	53.98	3.521 to 3.786	< .001
Resource constraints (z)	-0.100	0.034	-2.99	-0.166 to -0.035	0.003
Policy alignment (z)	0.275	0.035	7.93	0.207 to 0.343	< .001
Leadership support (z)	0.186	0.024	7.70	0.139 to 0.234	< .001
Community collaboration (z)	0.104	0.022	4.66	0.060 to 0.148	< .001
Diffun II district	-0.009	0.077	-0.12	-0.161 to 0.142	0.904
Resource constraints $\times$ policy alignment	0.101	0.031	3.26	0.040 to 0.161	0.001

Note. Gaussian GEE with exchangeable correlation; school was the clustering variable. Continuous predictors were standardized. Diffun I was the reference district.

Figure 3. Predicted sustainable-practice scores across resource constraints at lower and higher policy alignment



Note. Predictions held leadership support and community collaboration at their means and used Diffun I as the reference district. The positive interaction indicated a buffering pattern.

3.7 Qualitative Case Findings

Six themes explained how focal schools sustained or lost momentum under constraint. Themes were evident across both districts, although their expression differed according to access, leadership continuity, stakeholder availability, and the type of resource required.

Table 9. Qualitative themes and implementation meaning

Theme	Evidence pattern and analytic meaning
Low-cost routines preceded capital projects	Stronger cases began with practices that could be repeated using existing capacity: scheduled clean-up and segregation, classroom energy checks, reusable materials, preventive maintenance logs, curriculum-linked local investigations, and routine hazard inspection. Capital requests were then tied to documented gaps rather than treated as the starting point of sustainability.
Policy became effective when translated into roles and calendars	Schools with stronger scores converted broad mandates into named coordinators, monthly or quarterly tasks, evidence forms, agenda items, and budget lines. Weaker cases relied on general awareness, one-time campaigns, or a single enthusiastic teacher without succession arrangements.
Learner participation increased continuity	Learners served as monitors, peer educators, garden or waste-team members, hazard mappers, and project documenters. Practices were more durable when participation was linked to learning competencies and classroom reflection instead of being limited to ceremonial environmental events.

Table 9 (continued). Qualitative themes and implementation meaning

Theme	Evidence pattern and analytic meaning
Community partnerships filled specific—not all—resource gaps	Barangays, parent groups, local offices, alumni, and private partners supported repairs, hauling, seedlings, containers, tools, transport, technical advice, and emergency supplies. Partnerships were most useful when the school identified a precise need, assigned counterpart responsibilities, and documented maintenance after donation.
Utility and maintenance constraints remained binding	Water reliability, sanitation repair, electricity cost, internet access, waste collection, and replacement of damaged equipment could not be resolved through behavior change alone. Schools sometimes initiated practices successfully but reduced frequency when recurrent costs, spare parts, transport, or technical support were unavailable.
Monitoring determined whether initiatives became institutional	Stronger cases reviewed evidence through school meetings, implementation plans, WinS or DRRM monitoring, and classroom outputs. Weak monitoring allowed activities to become disconnected, duplicated, or dependent on reporting deadlines. Schools with usable indicators adapted their practice instead of merely repeating the same activity.

3.8 Integrated Findings

Integration showed convergence between the statistical and qualitative evidence. The strongest quantitative predictor—policy alignment—corresponded to qualitative evidence on role clarity, calendars, monitoring, and budget linkage. Leadership and community collaboration explained how schools mobilized action and targeted external support. The lower resource-efficiency and WASH means corresponded to cases where recurrent utilities, replacement equipment, and specialized maintenance remained binding constraints. The absence of a district effect was also consistent with the case evidence: stronger and weaker implementation patterns occurred in both districts.

Table 10. Joint display of quantitative results, qualitative explanations, and implications

Quantitative finding	Qualitative explanation	Operational implication
Overall practice was extensive (M = 3.60)	Most schools maintained recurring routines, but institutional depth varied.	District support should strengthen consistency, not merely initiate new activities.
DRRM and curriculum were strongest	These domains had established roles, schedules, and learning links that required less capital.	Use similar implementation architecture for waste, WASH, and resource-efficiency work.
Resource efficiency and WASH were lowest	Utilities, equipment, repairs, and recurrent maintenance created binding limits.	Separate low-cost practice improvements from capital and maintenance investment needs.
No significant district difference	High and low implementation cases existed in both districts.	Avoid district ranking; target school-specific constraints and capacities.
Policy alignment was the strongest predictor	Plans, assigned roles, monitoring, and budget linkage converted mandates into routine action.	Adopt a district policy-to-practice map and minimum evidence set.
Policy alignment buffered constraints	Organized schools protected essential routines and used evidence to mobilize support.	Prioritize management coherence alongside resource augmentation.
Practice correlated with continuity readiness	Sustainability routines strengthened communication, risk management, sanitation, and role clarity.	Integrate sustainability indicators with continuity and DRRM monitoring.

4. Discussion

The study found that sustainable education practices were extensive but uneven across the 32 sampled schools. The overall mean of 3.60 indicated that sustainability had moved beyond isolated awareness activities in many settings, yet the score remained below the level of consistent institutionalization across all domains. The results supported a whole-school interpretation: schools performed more strongly where sustainability could be embedded in curriculum, planning, roles, drills, communication, and community participation, and less strongly where implementation depended on costly infrastructure, reliable utilities, or specialized maintenance.

Climate resilience and DRRM produced the highest mean. This result was plausible within the Philippine basic education context because disaster preparedness had an established administrative architecture, designated coordinators, planning tools, drills, reporting expectations, and a direct connection to safety and learning continuity.^{5,7,18} The finding was consistent with whole-school ESD and comprehensive school-safety frameworks, which positioned sustainability and resilience as core institutional functions rather than optional environmental projects.^{14,23,27} The qualitative cases showed that hazard mapping, communication trees, emergency roles, and continuity procedures were sustained because they were visible, scheduled, and linked to immediate risk. This interpretation also aligned with recent Philippine evidence emphasizing climate-resilient schools as essential to educational continuity.²⁵

Curriculum and pedagogy also ranked highly. Teachers incorporated local environmental issues, responsible resource use, health and sanitation, disaster awareness, and community problems into learning tasks. This pattern reflected the central role of teachers identified by Timm and Barth: implementation depended not only on formal curriculum content but also on whether teachers could translate sustainability into meaningful, age-appropriate practice.²⁰ The focal cases further indicated that learner participation increased when sustainability activities generated observable evidence, such as waste audits, garden records, hazard maps, or community investigations. These practices were consistent with UNESCO guidance that connected sustainability competencies, climate action, and locally relevant pedagogies.^{21,28,29}

Resource efficiency was the weakest domain, while WASH was also comparatively lower. These domains included practices that could not be sustained through awareness alone. Electricity reliability and cost, water availability, toilet repair, drainage, connectivity, replacement of fixtures, waste collection, and maintenance skills imposed recurrent demands. The result cautioned against evaluating resource-limited schools using standards that conflated sustainability with expensive infrastructure. UNESCO's green-school standard promoted facilities and operations, but it also emphasized governance, learning, and community engagement.²³ A fair improvement approach therefore distinguished between practices schools could strengthen immediately and deficiencies that required district, local-government, or capital support. This distinction was particularly important for WASH because global monitoring frameworks treated safe water, sanitation, and hygiene services as measurable service conditions rather than awareness activities alone.^{8,26}

The district comparison was not significant. Although Diffun II had a slightly higher practice mean and a higher average resource-constraint score, neither difference met the conventional significance criterion. The small practice effect size suggested that district membership itself was not the principal explanation. This finding argued against ranking Diffun I and Diffun II. Variation within each district was more consequential: some schools under high constraints demonstrated coherent routines, while less constrained schools sometimes relied on fragmented or event-based activities. The result aligned with whole-school research showing that organizational quality, leadership, collaboration, and shared vision shape ESD implementation within the same policy system^{14,19}.

Policy alignment was the strongest predictor in the multivariable analysis. This construct did not refer merely to awareness of national mandates. It captured translation into school plans, role assignments, calendars, monitoring, budgets, curriculum expectations, and evidence review. A one-standard-deviation increase corresponded to nearly three-tenths of a point on the five-point practice scale, which was substantial relative to the observed differences among domains. The finding supported the argument that policy becomes consequential only when it is operationalized. A school with numerous memoranda but no integrated implementation map may experience policy overload; a school that identifies common requirements, assigns responsibility, and uses shared indicators can reduce duplication and protect recurrent practice.

Leadership support also produced a strong positive association. Qualitative evidence showed that school heads influenced whether staff regarded sustainability as additional work or as a method for improving school quality, safety, health, and learning. Leadership mattered through agenda setting, coordination, professional support, problem solving, and follow-through. This interpretation was consistent with research emphasizing proactive leadership and the continuous negotiation of a shared ESD vision^{10,13}. Importantly, leadership did not require the school head to personally manage every activity; stronger cases distributed responsibility and maintained succession arrangements.

Community collaboration was a smaller but significant predictor. Partnerships helped schools obtain materials, labor, technical advice, transport, repair support, seedlings, containers, and emergency resources. However, the qualitative findings demonstrated that donations alone did not create sustainable practice. Effective collaboration was specific, recurring, and linked to counterpart responsibilities and maintenance. This distinction is important for resource-limited schools: partnerships can extend capacity, but they cannot permanently substitute for public responsibility, recurrent funding, or basic utilities.

The direct effect of resource constraints remained negative and statistically significant after policy alignment, leadership, community collaboration, district, and the interaction term were included. This result confirmed that material limitations retained an independent association with implementation even after organizational capacities were considered. The positive interaction nevertheless supported the buffering hypothesis: at lower policy alignment, increasingly severe constraints were accompanied by a sharper decline in predicted practice; at higher policy alignment, the decline was attenuated. Policy alignment therefore functioned as an adaptive capacity, but it did not eliminate the need for essential infrastructure, utilities, and recurrent maintenance support.

The strong relationship between sustainable practices and learning-continuity readiness broadened the practical value of ESD. Sustainability routines were not peripheral to educational delivery. WASH, risk assessment, communication, records protection, resource management, partnerships, and role clarity helped schools prepare for disruption. This relationship supported the integration of sustainability, DRRM, health, and continuity planning rather than their management through separate committees and reporting cycles.^{7,8,18,25,27}

Overall, the evidence suggested that the most productive strategy for resource-limited schools is neither to normalize scarcity nor to delay all action until resources improve. Schools require a dual approach. First, they should institutionalize practices that can be sustained through governance, curriculum, behavior, maintenance discipline, learner participation, and partnerships. Second, district and local authorities should identify and fund binding infrastructure and utility gaps that schools cannot resolve through internal effort. The distinction protects schools from being blamed for structural deficits while preserving agency for immediate improvement.

4.1 Policy and Practice Implications

- Establish a minimum viable sustainable-school package. Each school should maintain a small set of non-negotiable routines covering policy integration, curriculum linkage, learner participation, waste handling, WASH monitoring, preventive maintenance, DRRM, and partnership documentation. The package should specify evidence and frequency rather than require identical projects.
- Use a resource-constraint triage system. District monitoring should separate organizational gaps from capital and recurrent-cost gaps. Schools can be supported immediately on role clarity, planning, monitoring, and curriculum integration, while water, sanitation, electricity, drainage, connectivity, and major repair needs are consolidated for division, LGU, or external financing.
- Develop a policy-to-practice alignment map. Overlapping environmental education, WinS, waste-management, DRRM, climate, health, and school-improvement requirements should be mapped into one annual implementation matrix. A common map can reduce fragmented committees and duplicate documentation.
- Strengthen distributed leadership. Sustainable practices should not depend on a single coordinator. Schools should assign domain leads, integrate tasks into existing teams, document turnover procedures, and use regular meetings to review implementation evidence.
- Formalize community partnership compacts. Partnership requests should state the problem, expected contribution, school counterpart, maintenance plan, responsible persons, and monitoring evidence. This structure can improve accountability and reduce one-time or mismatched donations.
- Link sustainability to school-based inquiry. Teachers and learner organizations should examine practical questions such as water use, waste volume, material reuse, attendance during disruption, garden survival, or the effectiveness of risk communication. Small-cycle inquiry can make sustainability visible as a learning and improvement process.
- Avoid district league tables. District-level averages concealed substantial school variation. Monitoring should prioritize improvement trajectories and matched support rather than public ranking of Diffun I and Diffun II.

4.2 Proposed Diffun Sustainable Schools Improvement Framework

The findings were translated into a four-stage framework that could be used by the two districts. The framework begins with evidence and prioritization, proceeds to integration and implementation, and ends with review and scaling. It is designed to operate within existing school-improvement and monitoring processes rather than create a separate reporting system.

Table 11. Proposed Diffun Sustainable Schools Improvement Framework

Stage	Core actions	Expected evidence
1. Diagnose	Complete the resource-constraint and sustainable-practice profile; identify binding utility, infrastructure, organizational, and access gaps.	School constraint profile; baseline domain scores
2. Align	Map applicable policies into the school improvement plan, annual plan, budget, curriculum activities, WinS and DRRM processes, and assigned roles.	Policy-to-practice matrix; role and calendar map
3. Act and collaborate	Implement low-cost routines, learner-led activities, preventive maintenance, targeted resource requests, and partnership compacts.	Quarterly implementation evidence; partnership commitments
4. Review and scale	Examine indicators, continuity evidence, costs, maintenance, and learner participation; retain, adapt, stop, or expand practices.	School review note; district learning brief; next-cycle priorities

5. Conclusion

The study concluded that public schools in Diffun I and Diffun II Districts demonstrated extensive but uneven sustainable education practices. Climate resilience, DRRM, and curriculum integration were comparatively strong, while resource efficiency and WASH remained more vulnerable to infrastructure, utility, and maintenance limitations. The two districts did not differ significantly in overall implementation, indicating that school-specific conditions and capacities were more important than district membership. Policy alignment, leadership support, and community collaboration were the principal organizational enablers. Policy alignment was especially important because it translated broad mandates into plans, roles, calendars, budgets, monitoring, and classroom expectations. Its moderating effect showed that strong organizational coherence could protect sustainable practices under severe constraint, although it could not replace essential infrastructure and recurrent resources.

Sustainable education in resource-limited settings should therefore be pursued through a dual strategy: institutionalize low-cost, learning-centered, participatory, and evidence-based routines while directing external investment toward binding resource deficits. For Diffun, the most defensible path is not a competition between districts but a shared improvement system that diagnoses school needs, aligns policies, mobilizes local capacity, and tracks whether practices remain useful over time.

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